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THE AMERICAN

GAS LIGHT JOURNAL

REDMAN & KENNY, N.Y.

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, HEATING, MECHANICAL, CHEMICAL AND GENERAL SCIENCE.

VOLUME LXX. No. 25
Whole No. 1,254.

NEW YORK, MONDAY, JUNE 19, 1899.

$3 PER ANNUM,
IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager.
THOMAS J. CUNNINGHAM and ELBERT P. CALLENDER, Editors.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

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[Special Editorial Correspondence.]

TWENTY-SECOND MEETING, WESTERN GAS ASSOCIATION.

MILWAUKEE, WIS., June 14, 1899.

Dear JOURNAL: The first day's sessions of the current meeting of the Western Gas Association have just been brought to a close, and the pity of it all is that our forecast of a week ago came to pass. Having done much for the Association, and having at least fairly won his way, its President, Mr. George Treadway Thompson, through physical ills, was not able to be the convening officer. Much to gas men there must be in this failure, for if the old guard is not to be recruited from its youngsters, to whom shall we look for succession? However, if President Thompson, in his far-and-away sojourn in the hills of Colorado could have heard through his ears the many sounds expressing regret over his absence and the hearty belief that his stay in those hills was but sojourning, well would he have been repaid for the time and thought and work put by him into advantaging the trade for which the Western Gas Association stands. Despite the shift in the time for the meeting, which this year was put ahead one month over the regular order, the attendance was good, and the Association was served by an untiring Committee of Arrangements, by weather that was up to the Committee's efforts, and by an attention to detail which would have done credit to any body of electricians seeking to enlarge their business. The meeting was called to order this morning by the First Vice-President, Mr. I. C. Copley, whose Yalensian introduction of the Mayor of Milwaukee (Mr. David G. Rose) did not deter that democrat from believing that gas men of themselves were as well qualified to sell gas to the democratic city of Milwaukee as were the republicans of Mr. Copley's New Haven teaching place. Apart from the differences which may exist over gas practices in centers of population, it is sure that no June Rose ever made finer pretense than did Mayor Rose, and the smooth cordial intent of Mr. Paul Doty's response, who replied on behalf of the Association, showed quite well that the thorns were with the authorities, so far as the gas industry is concerned. The regular order of business was proceeded with on about these lines. Mr. William McDonald (Second Vice-President) assumed the chair, while Vice-President Copley read a letter from President Thompson detailing why he was absent from the meeting, supplementing the recital of the letter's lines by the reading of President Thompson's address. The message was of the sort that one would expect from a man of Thompson's calibre—no nonsense, much of value and all of worth were its paragraphs. Some routine business followed, notable in which was Secretary Dunbar's report, whose statement showed that the Western was up-to-date in every sense. The report of the Board of Directors, which followed Mr. E. C. Cowdery's presentation of the way in which it was proposed to entertain the Association during its stay in Wisconsin's handsome city, proved that the Association was up and doing. Its lines determined that a subscription of $100 per annum, over the 5-year period, should be made to the educational fund of the American Gas Light Association, and that the contention of the Spokane Falls (Wash.) Gas Light Company, in its attempt to settle the question as to whether or not the electrolysing of gas mains by electric street railway companies must be paid for by the latter, should be pecuniarily upheld by the Association. A telegram of regret having been sent to President Thompson, the election of new members (47 active and 9 associate) was proceeded with, and action was further ordered in respect of the publication of the proceedings of the Association. This brought the business to the first paper on the list, that by Mr. Paul Doty, of Grand Rapids, Mich., on "Causes Underlying the Formation of Naphthalene and Their Prevention." In the discussion on this paper, a notable participant was Mr. Hans Buhrer, Engineer of the gas plant at Dessau, Germany, who was present at the meeting as the joint guest of the Steinwedells, senior and junior, of Quincy, Ills. The second paper was by Mr. B. E. Chollar, of St. Louis, Mo., whose dilations on "A Foundation that Failed and the Lesson it Taught" provoked a discussion that brought out a thought or two respecting the collapse of the Consolidated Company's holder in this city last year. The next thing to occupy the attention of the members was the paper, by Mr. E. E. Eysenbach, of Columbus, O., whose practical speech, on "Cyanides in the Gas and Waste Products at Columbus," brought out a good debate. A dip into the Question Box settled five queries in a profitable way, and the paper by Mr. F. B. Wheeler, of Binghamton, N. Y., entitled "Problems in New Business: Some History and Experiments," with its animated discussion, terminated in good shape the regular business of the first day.—S.

MILWAUKEE, WIS., June 15.

Dear JOURNAL: Last night's story may be summed up in the statement that Cowdery is King of the Hosts; no more may be said. The regular order to-day was the election of officers as a starter. Those named were:

President—William McDonald, Albany, N. Y.

First Vice-President—I. C. Copley, Aurora, Ills.

Second Vice-President—T. D. Miller, Dallas, Tex.

Secretary and Treasurer—J. W. Dunbar, New Albany, Ind.

Directors—Z. T. F. Runner, George McLean, B. W. Perkins and John Gimper—to serve two years. A. H. Barret was named to serve as Director in place of Mr. T. D. Miller for the short term.

The significance of the change of order shown in the election is merely that Mr. Copley visits Europe next year, which further goes to show that the Association insists that Mr. Copley will have to preside in 1901. Other routine business followed, the regularity of which was somewhat interrupted by the receipt of a "good luck cable" from "Gus." Littleton, who, from Vienna, Austria, in substance said he was sorry he was not with the boys and their sons in the neighborhood of Pabst's. Chicago having been named as the next meeting place, and a telegram from President Thompson having been read, the "Wrinkle Roll" was unfolded by Editor Jenkins. And a right good story he told, too, regardless of the fact that, betwixt '98 and '99, he removed from Niagara Falls to well beyond the Falls of the Rio Grande. The "Wrinkles" were followed by the reports of the "Committee on Isolated Generators for Bench Firing." I say reports, for each of the Committee (three in number) handed in his own determinations, and you may be sure that the Bredel-Butterworth-Steinwedell symposium is well worth reading, as is the discussion which it brought about. The afternoon session was opened by the final sifting of the contents of the Question-Box. Next in order was the paper by Mr. F. H. Shelton, of Philadelphia, who had, as usual, something original to say in his text over "Furnishing Gas at High Pressures and without Leakage." If a goodly shifting of tongues in speech recompensed him for his writing he was more than repaid in the succeeding debate; and the same might be said about Mr. Irvin Butterworth, of Columbus, Ohio, who advanced novel arguments in support of "Vitrified Clay Pipes Instead of Iron for Gas Mains." Here followed more routine business which included a very handsome report from the Committee on Final Resolutions. The Committee's report expresses to the full the JOURNAL'S ideas as to the completeness of the attention given us by our hosts, to which I may add on my own account that the meeting was thoroughly successful from a technical standpoint. To-night is the banquet; tomorrow I will have a word to say about it. Meanwhile let me end this in the remark that as near as I can figure it out from what has been told me, the gain in sendout through the West, as between last year and this, averages 12 per cent. I might also say that the news from Cincinnati, O., showing that the Board of City Affairs had refused to grant a franchise to the projectors of the Cincinnati Natural Gas and Illuminating Company, was much discussed. And it was agreed all round that General Hickenlooper still remained a doughty warrior, even though his Company in gaining its point promised that the selling rates should be 75 cents per 1,000 on illuminating account, and 50 cents per 1,000 for a fuel use.—S.

MILWAUKEE, WIS., June 16th.

Dear JOURNAL: The banquet last night was a most enjoyable affair, and was shared by 12 of the gentler sex and 170 of the other sort. Toast master McDonald capably directed the proceedings, and all agreed when the breaking up came that the Hotel Pfister men, Mr. Cowdery and his associates were adepts in the art of entertaining. This morning the weather is perfect, and at time of telegraphing we are getting ready for the trip to Waukesha Beach, which trip is to be punctuated by a short stop at the famous Pabst Brewery. Luncheon will be served at the Beach Pavilion. Next in order is a steamboat ride over the romantic Lake Pewaukee, the return to be marked by a visit to and an inspection of the Soldier's Home. The programme is so arranged that all will be able to leave Milwaukee for home by the early evening trains. The meeting has been a most successful one, and does great credit to those who directed it.—S.

Supt. Knowles on the Reconstruction of the Richmond (Va.) Gas Works.

Last week we noted that Mr. W. H. Knowles, Supt. of the Richmond (Va.) City Gas Works, in conformance with a request from the Committee on Light of the City Council for such information, had reported as to the construction, and cost of same, necessary to put the gas plant in a condition to meet the demands likely to be made upon it by the residents for the ensuing 20 years. Since that writing we have received the full report, the substance of which is as follows:

"*Improvements Necessary.*—1. Erect a boiler and engine room of sufficient size with necessary division wall, and to place therein two 50 horse power engines, oil heater and a new 48-inch oil heater, and two No. 8 high pressure Sturtevant blowers on adjustable base, rearranged with a galvanized iron pipe to overhead system, making the pipe 24 inches in diameter. By the above changes you will have sufficient room to move your generators back, thereby allowing space to install two carbureters, 7 feet in diameter, with reverse steam connections, water-cooled valves and firebrick lined connections. Rearrange the brickwork in the vapor heater, enlarging the stack valve and the off-take connections from 12 to 16 inches. Dispense with the present wash boxes and replace them with those of 6 feet diameter. The condensing service in the present water gas plant is inadequate; therefore, there should be added one 8 feet 6 inches by 22 feet condenser, and all connections between wash boxes and condensers should not be less than 16 inches. All of the above changes are absolutely essential in order to put the water gas plant in first-class condition, and it is necessary to do this in order to obtain the most economical results, such as are obtained in all first-class water gas plants. The approximate cost of the above would be about $20,000. I should say that if these changes are made, you could save about $5,000 a year.

"2. To separate the water and coal plants. In all well regulated gas works it is now the practice to measure the water gas and coal gas separately. This is essential in order that the efficiency of each part of the combined plant may be definitely arrived at. To do this it is necessary to enlarge your present coal plant, engine and boiler room 13 feet, place therein one No. 7 Roots gas exhauster with engine on same bedplate, with all necessary by-pass connections with present water gas main; rebuild the drum of the old plant station meter, which will be used to register the amount of water gas made, mixing the water and coal gas at the inlet of the purifiers. The above changes can be made for about $4,500. I must urge upon you the necessity of making this change.

"3. Coal gas plant be remodeled, and in place of your present benches of 6's there be erected the most improved full-depth recuperator 9's, or inclined benches of 1,500,000 cubic feet capacity for 24 hours, with all necessary mechanical appliances for their successful operation, and at the same time it will place you in a position to manufacture either gas at the very lowest cost, and if the price of material increases in either case, you can manufacture by either process which may be the more economical at the time. This change would cost about $55,000, and the saving would be about 15 or 20 per cent.

"4. Extend the 24-inch main from 28th and Water streets to 15th and Dock streets, connecting with the 20-inch feeder at this point, thereby doing away with the necessity of running your exhauster at the upper works to supply your holders. This will cost $12,834.

"5. Put new top on large holder at the lower works. This will cost about $2,500.

"6. You should erect a new storage holder in the west end of the city. If this is done, you should not build one of less than 1,500,000 cubic feet capacity, and I strongly recommend that one of 2,000,000 cubic feet capacity be erected. This holder to be erected in a steel tank. The approximate cost of this holder, including the price of land, would be $150,000. You would then be able to equalize the pressure and reduce the consumers' bills in the west end of the city, and you would also be able to get a better distribution of gas. Twice in the month of February the city has been in darkness for a lack of sufficient storage capacity, and frequently we had to stop the plant in the summer months on account of not having storage. This necessitates a great loss of labor and fuel. Our present storage capacity is only half of our maximum daily output. With your largest holder in need of repair, if by accident either of your three holders should be put out of use in the winter months, I doubt if the city could be supplied with gas, and, if it could, it would be at a very large increase over the present cost. If the city will make the above improvements you will have a first-class modern plant. Your plant will have a generating capacity of 2,400,000, and a storage of 2,200,000 cubic feet, which will supply the demands of the city for the next 15 or 20 years. If the city will make these improvements, you will then be able to furnish its consumers with gas of first-class quality as well as quantity, and can then reduce the price of gas. I wish to inform you that the machinery installed in your coal plant, though old in style compared with modern plants, is in good condition, and with the proper material will make as good gas and as much of it as has ever been made with this style of apparatus. In conclusion I would say that to day we have an inferior water gas plant, which is incapable of making a properly fixed gas. It cannot properly scrub and condense the gas after it is made. The coal gas plant, although in good repair, is what is now being discarded in all works which have a sale of over 50,000,000 cubic feet per annum. Our method of measuring the gas as made is such that it is impossible now to determine definitely the exact amount of water was and coal gas made, all of which is extremely bad practice. I wish also to say that the condition of our large holder is such that I do not feel that I should have to take responsibility of the supply of gas for the city of Richmond, as this holder is in bad condition, and has been in need of repairs for the past four or five years. In this shape it is liable to have to be thrown out of use at any time, and should this occur at any other time than the three summer months, it would be impossible to keep up the supply of gas for the city as it should be kept up. In other words, there would certainly be a deficiency of pressure in certain parts of the city.

"I feel no hesitancy in saying that no first-class gas works would, in my judgment, hesitate to appropriate the necessary amount to make these changes which would give the city a modernized plant, and a majority of them would set aside each year a part of their surplus earnings for the purpose of making further extensions and improvements. You should also appropriate from $800 to $1,000 to have complete drawings made of your works as they now exist, and the plan showing the extensions and improvements that I have recommended; also to prepare proper map for street mains. In connection with the outlying holder it will be necessary to install a pusher plant at the Lower Gas Works. The Sturtevant fan exhauster is the type that should be used. The engine, belts, countershafting, pulleys, etc., with by-pass connections, will cost about $6,500."

[Written for the JOURNAL, by "Gas Engineer."]

Gas Pipe Engineering.

As is known to gas engineers, long continued service of gas pipe materials, in connection with the influence of gases and atmospheric changes, eventually results in certain changes in the structure and properties of the parts. Pipes and piping materials that are exposed to alternate moisture and dryness, to fumes of acids in bleacheries or dye plants, to steam discharges in boiler rooms or steam laundries, to dampness in underground places, to rust, wet, etc., necessarily alter in their composition. In some cases the structure of the material becomes more crystalline and brittle. In others the metal loses some of its ductility. If the metallic portions were tested for the yield point and tensile strength, after several years' of service in exposed places, both the former and the latter would register differently from the original

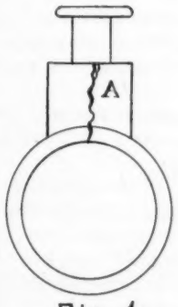


Fig. 1

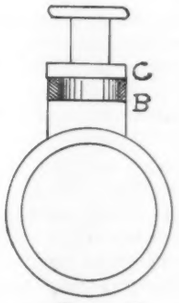


Fig. 2

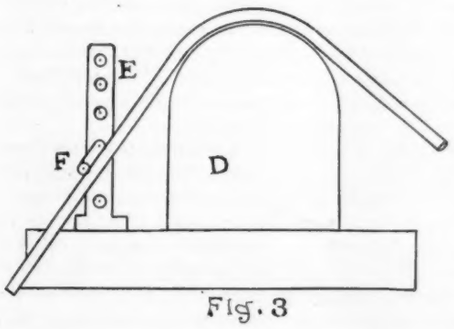


Fig. 3

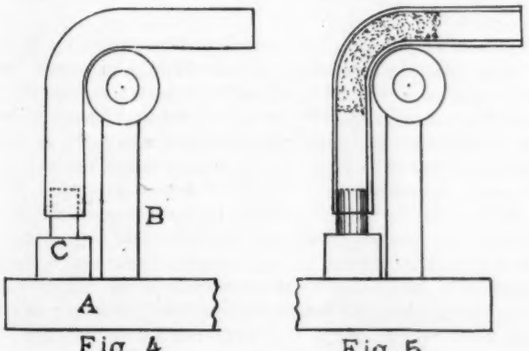


Fig. 4

Fig. 5

Practical Topics Concerning Gas Pipes.

test. Ordinarily the yield point will be lowered and the elongation decreased. The best of gas piping material has been found changed by continued service in places exposed to hot gases, such as in the vicinity of a furnace or heating plant of residence or other building. Of recent years, therefore, gas engineers have given more attention to the inspection and testing of gas pipe and gas pipe fixtures, from this standpoint. The deterioration can be easily traced by proper inspection and probably rectified. If the deterioration is permitted to continue, defects are liable to be produced in the piping system which may result in a gas explosion. The fire insurance companies now have special inspection agents in their employ to locate lurking dangers of fire or explosion in gas piping fixtures, and the gas engineer and pipe fitter are obliged to be quite alert. In making inspections for defects in the pipes or fixtures, the conditions of the surroundings should be taken into consideration. If the parts have been in places exposed to influences that tend to change the structural tests of the metals, the parts should be examined for flaws or tested for weak places. In one test recently the pipes were jacked to walls of an ice making plant, in which there were constant fumes from the acids used in the artificial process of ice making. The jacks for running the pipe along the wall were made from a metallic mixture, about 10 per cent. alloy, which, under ordinary circumstances, would answer all purposes. Some of these jacks were cracked at the shoulder, as at *A*, Fig. 1, and threatened to let the pipe drop. A test of the metal in these jacks proved that it had changed to a very brittle state. A remedy was found by removing the jacks and

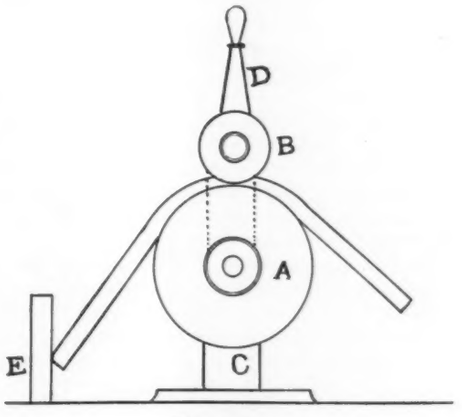


Fig. 6

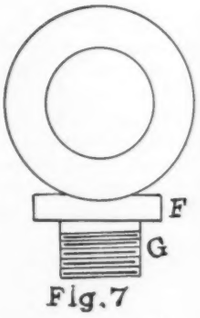


Fig. 7

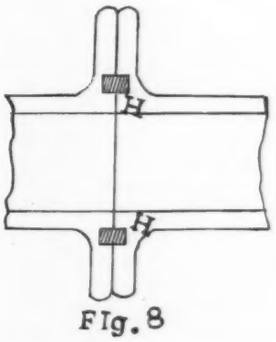


Fig. 8

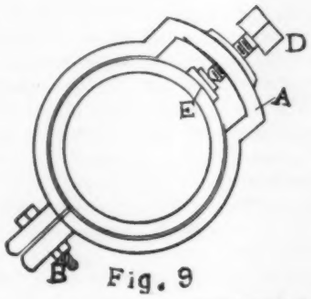


Fig. 9

Fig. 10

Bending Gas Pipe.

cutting out a groove, *B*, Fig. 2, in the shoulder of each by blocking the jack in a lathe and doing the cutting with a steel cutter. Then brass rings, *C*, were made and expanded and slipped over the head of the shoulders into the groove of each. These rings served to hold the cracked flanges tight and strengthen the others.

Some Points on Bending Gas Piping.—Processes of bending gas piping are varied, but the simple form shown in Fig. 3 is useful for general work. This type of bender is made of a wooden round block, *D*, fixed to a base piece as shown. Then a stand piece, *E*, is set up back of the block and provided with a series of holes and a pin, *F*. The piece which is required for bending is filled with rosin, or similar substance, and one end is placed under the pin, *F*, and the other is bent

over the block by hand pressure. This process does not require any heating of the pipe, and if the latter is well packed there will be no danger of the shell collapsing or buckling. If the pipe wall does collapse through lack of packing, a pinhole may be bored in the wall over the depressed place, a hooked rod inserted and the wall drawn up into place. Then the pin hole can be plugged.

Bending with a Spiral Spring.—The spiral spring method of bending consists in winding a steel or brass spring the diameter of the interior of the pipe to be bent. This may be done by winding the wire on a steel rod of proper size. Then the wire spring is pushed into the pipe and the pipe is bent over a form. If properly done the pipe can be bent to any angle without its buckling. A good type of device to use in connection with this process of bending is presented in Fig. 4. The platform, *A*, is provided with a stand, *B*, at the top of which is a stud for receiving the iron wheel, *D*. This wheel is grooved. A pin is set up at *C*, and after the spiral spring is pushed into the pipe the pipe is placed with one end over the pin *C*, while pressure is applied to the other over the grooved wheel, as shown.

Filled With Clay.—Fig. 5 shows the same form of bending device used in connection with a clay filled pipe. If the pipe is not very heavy, clay or putty can be used to advantage. The clay is simply packed into the pipe as hard as possible, and the bending done, as in Fig. 4. Hot bending is done to a considerable extent, but the danger of injuring the metal by overheating is so great that the cold bending processes are preferred by many engineers.

The Wheel and Lever Method of Bending.—In Fig. 6 is shown a homemade wheel and lever gas pipe bender, which can be constructed by any gas pipe fitter with few tools and parts. The main wheel, *A*, should be about 10 inches in diameter and grooved to about the average size of the pipes handled. The smaller wheel is pivoted at *B*, just over the larger wheel, and its groove corresponds with the groove of the larger wheel. The larger wheel is studded firmly to the upright, *C*, to which is also pivoted the lever, *D*. The piece of pipe to be bent is placed between the grooves of these wheels, and with one end of the pipe against the pin *E*, the other end is bent around the wheel to desired angle by means of bringing down the lever *D*.

For Lifting the Top from an Air Valve.—The top sections of air valves are usually so freely cut with threads that it is difficult to handle them. In Fig. 7 is a little homemade device invented for this work. It consists of a ring of wrought iron secured to a washer, *F*, and the latter is headed to a section of threaded pipe of the same size as is used in the average air valve. Therefore, when desiring to elevate the top from an air valve, instead of injuring the threads by crude tools, the cover is merely unscrewed, this little device screwed into place and the top lifted up by means of the ring.

When Heavy Flanges Shift.—Gas engineers are often troubled by the flanges of gas mains shifting slightly, even when secured with apparently firm flange bolts and connections. There are certain influences that will cause the best designed flange connection to shift and perhaps result in leakage. In Fig. 8 is a style of cutting out the faces of the flanges of the pipe joint at *H H*, into which a ring is placed, key-fashioned, for preventing the shifting of the flanges. This process consists in cutting a groove around the face of each flange, which is done easily in any turning lathe by securing the section of pipe to the bed-plate and revolving it on a cylinder, or by securing the pipe stationary to the bed and slotting the groove with a cutting tool turned in the face plate. After the groove is cut in each flange a corresponding ring is made and slipped in as the flanges are closed. After bolting and packing the joint the connection becomes very secure, and can withstand excessive vibration accompanied by mechanical strains and various mechanical movements without working loose.

The Troublesome Small Leak.—In Fig. 9 is shown a good way to stop a troublesome little pinhole leak in a gas main. It calls for a forged iron clamp to fit over the pipe and bolted at *B*. This clamp is provided with an extension at *A*, into which the set screw *D* is tapped. Say the leak is at *E*, for instance. The clamp is adjusted so that the tip of the set screw will point directly to the leak *E*, over which is first placed a soft metal washer, topped with a hard metal washer. The point of the set screw is now brought down upon the latter and the soft washer is forced firmly to the leak, effectually stopping it.

When the Interior can be Reached.—If the interior of the pipe can be reached, it is a good idea to drill out the ragged leak to receive a common bolt *F*, as in Fig. 10. This bolt is fitted with the proper equipment of rubber and metal washers to allow the leak to be closed by compressing the washers on the pipe shell by means of tightening the nut.

A New Method for the Estimation of Carbonic Oxide.

According to Messrs. Schlagden and Pagel, Mr. Nicloux has recently published a method for the estimation of carbonic oxide, based on the oxidation of this gas on contact with anhydrous iodic acid at a temperature of 150°, according to the following reaction: $5CO + 2IO_3H = 5CO_2 + H_2O + I_2$.

The apparatus of which he makes use is arranged so as to absorb the iodine by means of a weak solution of caustic soda. When the operation is ended we add a little nitrite of soda and sulphuric acid until the reaction is distinctly acid; agitate with sulphide of carbon, and titrate the more or less colored solution by comparison with a typical solution containing a known quantity of iodine.

On examining the very simple equation of this reaction it seemed probable to us that other oxygenated compounds might behave in a similar manner. We therefore undertook a first series of experiments with molybdic, chromic, arsenic and arsenious, stannic, antimonic and antimonious acids, but without the slightest success, since none of them was reduced either at 150° or at higher temperatures varying between 200° and 300°.

Following up these negative results, we commenced a new series of operations with some metallic oxides—oxides of silver, lead, bismuth and copper—with the following results:

1. *Oxide of Silver.*—Oxide of silver, previously dried in an air oven at a temperature of 150° and placed in a **U**-tube in a water bath, is submitted to the action of a current of pure carbonic oxide, absolutely free from carbonic acid, by means of a flask filled with baric hydrate. On leaving the experimental tube the gaseous current is passed through another barytic solution which begins to become cloudy when the temperature reaches 50°. Between 54° and 60° the white precipitate becomes very abundant, and thus indicates the presence of a large proportion of carbonic acid. At the same time the color of the oxide of silver changes; the original dark brown color gives place to a brilliant white appearance. By gently shaking the **U**-tube, so as to allow the gas to penetrate the pulverulent material more intimately, we find that the operation is terminated after the lapse of a few minutes. The deoxidation of the metallic oxide is thus effected, and the carbonic oxide is transformed into carbonic acid.

To decide whether it is possible to formulate this experiment thus, $CO+Ag_2O=CO_2+Ag_2$, we substituted for the barytic solution a Liebig's tube filled with potash at 50 per cent. weighed before and after the passage of the gas. With 2 grms. of oxide of silver we observed, under the same conditions as to temperature as above, a loss of 0.145 grm. of oxygen. The corresponding quantity of carbonic acid is by calculation 0.385 grm.; this figure is absolutely the same as that given by the increase of weight of the potash tube, which, therefore, proves that the experiment is entirely in accord with theory, and that the above formula is justified.

2. *Cuprous Oxide.*—We take cuprous oxide, heated in the air oven to 150°, and proceed as above, placing the **U**-tube in a water-bath, but nothing comes over even when the water is boiled; the barytic solution does not become cloudy. By using an oil-bath we notice a slight cloudiness at about 125°. The precipitate of carbonate of baryta becomes abundant at 215°; at this moment the color of the material in the tube changes, becoming red, instead of brown as it was originally. Then, towards 300°, we notice a lively incandescence takes place, indicating the end of the operation, and the whole of the oxide is transformed into metallic copper, having a crystalline aspect. The reaction is effected in the same manner as the preceding one, viz., $CO + Cu_2O = CO_2 + Cu_2$, from which we may safely say that it is the result of an estimation carried out under the same conditions as those with the oxide of silver. We have in fact:

Oxygen used	2 grms.
Loss of oxygen	0.25 grm.
Theoretical amount of carbonic acid	0.680 "
Carbonic acid found	0.685 "

The concordance between the two latter figures is perfect, since the temperature to which we carried the cuprous oxide was a little too high. At 150° the suboxide begins to change into cupric oxide; this is a source of error easy to prevent.

3. *Oxide of Bismuth.*—In submitting oxide of bismuth, dried at 150°, to the action of a current of carbonic oxide, on an oil-bath at 230°, the barytic solution through which the gas passes commences to become cloudy. The precipitate increases at 260°, at the same time as the color of the material changes; it becomes yellow, instead of white as it was originally. Between 385° and 400° it becomes black, and

changes into the suboxide, but not into metallic bismuth. This result might, however, be foreseen, as various writers agree that the suboxide is very difficult to reduce. If, instead of allowing the suboxide to cool in the experimental tube, we throw it out while still warm, it changes rapidly into Bi_2O_3 with bright incandescence.

4. *Oxides of Lead.*—The oxidized compounds of lead behave in different manners on contact with carbonic oxide. With minium, for example, we notice that deoxidation already begins at 225°, while litharge does not appear to be attacked below 300°. The white oxide derived from the hydrate, previously heated in the oven to 150°, is deoxidized with still greater difficulty. It gives metallic lead when the temperature of the oil-bath is carried to 430°, but the reaction is not so sharp as with the oxides of silver and copper, since the metal remains mixed with a certain quantity of suboxide, without, however, containing carbon, as stated by M. Boudouard in speaking of Lowthian Bell's experiments.

To sum up, the oxides of silver and copper, heated in a current of carbonic oxide, are entirely deoxidized, the first at 60°, the second at 300°, and may consequently serve to completely absorb this gas. As the carbonic acid formed corresponds theoretically with the oxygen lost, it follows that this reaction constitutes a new method for the estimation of carbonic oxide.

The World's Consumption of Pig Iron in the Steel Industry.

By Mr. J. S. Jeans, London, in *Iron Age.*

The most remarkable feature of the iron trade of to-day is probably the extraordinary increase in the quantity of steel produced relatively to the quantities of iron applied to other purposes. The total quantity of pig iron produced throughout the world in 1898, so far as the figures enable a computation to be made, was about 35,000,000 tons. For the same year the total production of steel of all kinds was about 25,000,000 tons. If we allow 10 per cent. for loss in conversion this would mean that 27,500,000 tons of pig iron, or 78½ per cent. of the total make of the world, was converted into steel, leaving only 7,500,000 tons for conversion into malleable iron, foundry castings, etc. Of course this does not mean that the material available for either purpose was limited to the figures, the fact being that an enormous but quite unascertainable proportion of scrap iron steel has been used up for many different purposes, and more especially for the steel industry—notably the open hearth process—from year to year. But so far as the pig iron production of the world is concerned these figures represent approximately the ratio of its apportionment, assuming that only pig iron was applied to the manufacture of steel and other products of mills, forges and foundries.

Thirty years ago the condition of things was startlingly different. In the year 1868 the world's make of pig iron was about 9,500,000 tons. Of this quantity only about 350,000 tons, or approximately 4 per cent., was applied to the manufacture of steel. Of the remainder the greater bulk was applied to the manufacture of puddled iron, which was then the reigning finished product, and of which the total annual output, so far as can be computed from the figures at command, was about 5,000,000 tons.

If we come down to 20 years ago, we find in 1878 that the world's make of pig iron had advanced to rather over 14,500,000 tons, and the total make of steel had increased to about 3,163,000 tons, of which 2,563,000 tons were Bessemer, 320,000 tons were open hearth and 280,000 tons were crucible and other descriptions. These figures would represent a consumption of about 3,479,000 tons of pig iron, assuming that description to be wholly applied to the manufacture, or 24.7 per cent. of the total pig iron output of that year. At this time, however, malleable iron still held its own very strongly, as indeed it did for a number of years afterward. In the United Kingdom the maximum yield of puddled iron was reached in 1882; in the United States the maximum was attained in 1881. In Germany the maximum was not reached until 1889; in other European countries the make of puddled iron continued to advance until a considerably later date.

By the year 1888 the total make of pig iron had reached 24,000,000 tons, and the total make of steel was about 9,754,000 tons, of which 7,812,000 were produced by the Bessemer, 1,692,000 tons were produced by the open hearth and 250,000 tons by the crucible and kindred systems. This output of steel, allowing again 10 per cent. for waste in conversion, would call for the consumption of 10,729,000 tons of pig iron, or 44½ per cent. of the total make, assuming it to have been applied exclusively to that purpose.

Since, therefore, the world's steel trade now annually absorbs the equivalent of 78½ per cent. of the world's annual total make of pig iron, it is clear that the progress made in this direction during the last ten years has been phenomenal and entirely without precedent. It is not possible to state the quantity of puddled iron now made throughout the world, because certain countries, the United States and the United Kingdom among them, do not now claim to publish exact statistics of this branch of the iron industry, and it is probable that no other countries can be much more definite, however they may profess otherwise, because of the almost universal custom in all the leading iron making countries of rolling steel billets alternately with puddled blooms in iron rolling mills. But the total make of puddled iron, so far as the figures can be computed, is not likely to day to be less than 5,000,000 tons—Great Britain and Germany alone producing 2,250,000—which would call for a further consumption of 5,500,000 tons of iron. This would bring the consumption of iron for steel and malleable iron together up to 32,500,000 tons, or within 2,500,000 tons of the total ascertained pig iron production of 1898.

It is at this stage that the troubles of the problem which we have essayed to try to solve begin to crowd thickly upon our heads. There is no record of the quantities made of other descriptions of iron and steel in their ultimate forms, other than steel and manufactured iron, except for Germany, which in this respect sets an admirable example that other countries could hardly do wrong to follow. According to the German returns the total annual output of foundry castings in that country is about 1,500,000 tons. In other words, about 20 per cent. of all the ultimate products made in that country takes the form of foundry castings. It is probable, although far from certain, that the ratio between foundry castings and other finished products will not be greatly different in other countries. If this is near the mark—and it is certain we cannot, by any amount of conjuring with figures, get much nearer to it—then it would appear that the total tonnage of foundry castings made throughout the world would amount to about 6,000,000 tons, and this would represent a consumption of over 6,500,000 tons of pig iron, again assuming that the waste and loss by oxidation are about 10 per cent., although of course it may be and probably is a good deal under that figure. In other words, to the 2,500,000 tons of our pig iron product left over after we had provided for the requirements of the steel and malleable iron industries, there would need to be added 4,000,000 tons to make up the full quantity required for the foundry industry as a whole. Apparently, therefore, this is where the consumption of old iron comes in, but the figure is necessarily purely conjectural, and may be either more or less than 4,000,000 tons. That it is considerable is sufficiently proved by the fact that old iron for re-manufacture figures to a considerable extent in the export returns of certain countries, and especially of the United Kingdom, which appears to be the greatest storehouse of that commodity. A considerable quantity of the old iron so exported does not figure in the returns with which we have just been dealing, being exported to China, Japan and other countries and worked up there in primitive forges, of the operation of which facts are rarely available. To the extent of this consumption, which, however, is relatively unimportant, the quantity of scrap iron annually disposed of is greater than the figure at which we had arrived.

It comes in the long run to this, that for the requirements of the steel, malleable iron and foundry business of the world the present annual consumption of materials, whether in the form of pig iron or of scrap and similar materials, is close on 40,000,000 tons a year, which is four times as much as the corresponding consumption of 1868, 2¾ times as much as the consumption of 1878, and about 50 per cent. more than the consumption of the year 1888. If no scrap iron were available the steel industry alone, as we have pointed out, would absorb to-day 78½ per cent. of the total pig iron make of the world. Judging from the history of the immediate past, it is probable that in the future steel will go on absorbing a relatively larger proportion of the world's pig iron output. On the other hand, it is equally probable that the finished iron industry will continue to absorb relatively less. From this point of view the outlook is not one that need cause much anxiety. But the "dark horse" of the situation is the scrap iron supply. An enormous supply of scrap must always be furnished by the steel industry itself. Outside of the supply available in the form of crop ends, etc., it is probable that the quantities available will continue to increase absolutely if not also relatively. Since the year 1870 more than 200,000,000 tons of iron have been made and put into consumption in all the countries of the world. Of this vast volume how much continues in use? Is it one-third, or one-half, or what other proportion? It is clear that whatever the true figure may be the available supply of scrap must be enormous, both from reconstructions and from disuse of a thousand dif-

ferent structures in which iron and steel are employed. It is probable, moreover, that if the quantities of scrap thus at command could be approximately estimated it would exercise a considerable influence on both the present and the future of the world's iron supplies. For most practical purposes of the steel manufacture scrap iron is just as good as pig iron. The ore, indeed, can readily be made to displace, and does largely displace, the others. As a rule, however, it is considerably more expensive, and for that reason it is not likely to be made use of on a large scale where pig iron is available. Hence the conclusion that steel manufacturers are not likely to encourage the use of scrap in the majority of ordinary cases.

There is another important raw material of the steel industry, the supply of which is causing considerable anxiety in Europe. In all countries where basic steel is manufactured on a scale of importance the last few years have developed a large demand for puddlers' top, which furnishes the essentials in which the pig iron ordinarily used is more or less deficient pure and simple. This material was originally disposed of in the early days—not yet remote—of the basic process, for the trouble of carrying it off. By and by it was paid for as a commodity of value, rising from 2s. 6d. to 5s., to 10s., to 15s. and to 20s. per ton. In Great Britain and Germany the supply is now getting somewhat scarce. In the United States, where the basic process is as yet in its infancy, this stage is not likely to be reached for a considerable time to come, and to this extent the basic steel manufacturers of the United States are likely to have a substantial advantage over their European rivals so long as the advantage lasts.

Rotary Transformers and Storage Batteries as Related to Long Distance Transmission.

[Abstract of a paper, by PROF. W. L. ROBB, read at the last meeting of the National Electric Light Association.]

The paper with the above title read at the meeting was stated by the writer, Prof. W. L. Robb, to have been prepared in response to a request from President Young to give at this meeting an account of the operation of the rotary transformers and storage battery installed and operated in connection with the long distance transmission plant at Hartford, Conn.

The main source of power of the Hartford plant is a water power on the Farmington river about 11 miles from Hartford, and capable of delivering under the most favorable conditions about 1,200 electrical horse power at the switchboard in Hartford. The power is generated by two 600-kw. 60-cycle alternators and transmitted to Hartford on the 3-phase system under 10,000 volts pressure. The water power is supplemented by an auxiliary steam plant in Hartford, consisting of two compound condensing engines having a combined capacity of 1,600 horse power, which operate one 600-kw. alternator and one 400-kw. rotary transformer, the latter being so arranged that it can be connected with the engines and operated as a direct or alternating current generator whenever, owing to low water or other cause, the supply of alternating current is insufficient.

Two systems of distribution are used. In the central portion of the city the distribution is on the 3 wire 220-volt direct current system, all practically underground, the feeders being lead-covered cables drawn in cement lined ducts. Outside the central portions of the city the feeder is supplied with 2 phase alternating current at 2,400 volts and the distribution is in general on the 3-wire 220 volt system supplied principally from 10 and 25-kw. transformers. This service is in part underground, but in general overhead.

Three rotary transformers supply direct current to the 3-wire direct current system. One has a capacity of 400 kw. and is located at the steam plant; two have a capacity of 250 kw. each and are located in the battery substation in the heart of the business section of the city and about three-quarters of a mile from the steam plant. The storage battery has a capacity of 2,500-horse power hours at a 5-hour discharge rate. All three rotaries and the battery supply currents to the same 3 wire system. The three alternators are always operated in parallel. At least one rotary transformer and storage battery are always connected to the 3-wire direct current system. The direct and alternating current systems are consequently interlocked, and the whole plant, including alternators, rotary transformers and battery, is practically operated in parallel.

The rotary transformers are of the 2-phase type, and so designed that by cutting in turns of the primary of the static transformers, the voltage of the rotaries may be varied between 230 and 360 volts. This wide range is necessitated by the fact that the rotaries are at times connected directly on the line, and at other times used in charging the battery, frequently at high charging rates. This wide range of voltage obtained from the rotary does away with boosters which would otherwise be necessary in charging. The rotary transformers are 2-wire and simply supply the current to the outside wires of the 3-wire system. The neutral wire is connected to the middle point of the secondaries of the two static transformers, this point being always midway as regards voltage, between the two terminals of the rotary transformer. The storage battery is at all times kept on the line for the purpose of regulation and to meet any emergency call for extra power. Two of the rotaries are started and brought to synchronism by induction motors built on the shafts; the third is brought to synchronism as a direct current motor, the current for this being supplied from the direct current system.

The three alternators, one operated by steam and the other two operated by water at a distance of 11 miles from the first, have been continuously run in parallel during the past three years and no difficulty whatsoever found in this method of operation. In the operation of the rotary transformers it was found that a very soft-treated carbon brush gave the best results. The carbon brushes are first raised to a red heat and then plunged in ordinary lubricating oil and allowed to cool. Vicious sparking that previously took place ceased when this type of brush was used.

At the outset, in operating the rotaries, considerable difficulty was encountered from pumping when the engines were supplying power to the system. This pumping could be traced to the variation in the angular speed of the engines, there being little, if any, when the water power alone was supplying power. It was found that this tendency to pumping could be checked by varying the field of excitation of the rotary transformers, or by temporarily throwing a portion of the load on the storage battery.

A third rotary recently installed has operated perfectly by itself, but when thrown on the line with the two older rotaries they immediately began pumping, and it was found impossible to run the three together. Copper strips were attached to the pole pieces of the new rotary, and the tendency of the system toward pumping was entirely overcome by this means. Even under the trying condition of running rotaries under different voltages, two feeding directly into the line and the third independently charging the battery, no trouble with pumping is now experienced. In all other respects the original rotary transformers have been all that could be asked for. They have run practically continuously night and day for nearly three years and have had practically no repairs, the commutators being simply turned down once or twice a year.

The Hartford storage battery was bought under a five years' guarantee, which has since been renewed for an additional five years. The renewals have not been in excess of what was expected, and no investment of the company has been considered more satisfactory than the battery. The method of deciding when the battery is to be renewed under the guarantee is that whenever any plate and number of plates have lost one-third of the original capacity they are to be replaced by new plates. In this way the battery is being continually renewed, and its capacity should never be less than 90 per cent. of its original capacity.

The accompanying curves were taken from the daily records of the company, and illustrate the general operation of the plant and relative loads on the different systems. The parts shaded with horizontal lines represent the alternating current load, the upper portion representing the series arc lamps. The part shaded with diagonal lines represents the charge and discharge of storage batteries; the lines sloping to the right representing the discharge and the lines sloping to the left the charge; the horizontal dotted line represents the total full-load capacity and direct current machinery installed at the time. The unshaded area represents the direct-current load carried directly by the rotary transformers. An inspection of the charts representing the direct-current system shows that the average load on the rotaries during the 24 hours was over 80 per cent. of their rated full-load capacity. The maximum load on the system was 83 per cent. more than the full-load capacity of the rotary transformers. A comparison of the curves for the two days illustrates a great flexibility of the storage battery. On the Wednesday it was used at the high rate of discharge for a short period. On the Saturday the discharge was at a lower rate, but it was continued for a much longer time. The upper portion of the area representing battery charge and discharge, represents the charge and discharge of an isolated storage battery in one of the department stores.

The advantages of the rotary transformer and battery system to the Hartford company have, Prof. Robb considers, been very great. With the battery the company has been able to use a great quantity of water

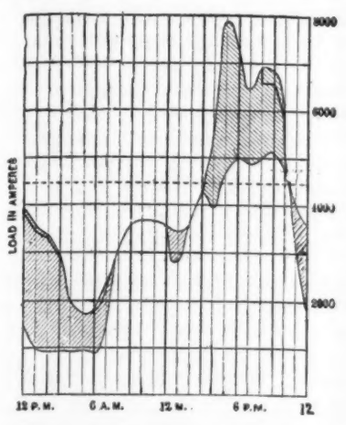


Fig. 1.—Direct-Current Load, Wednesday.

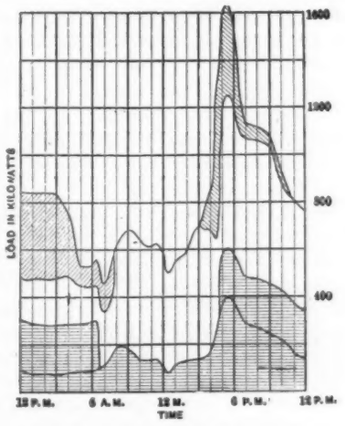


Fig. 2.—Total Load, Wednesday.

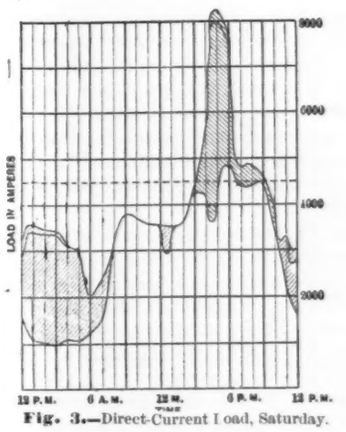


Fig. 3.—Direct-Current Load, Saturday.

power that would otherwise have gone to waste. What would otherwise have been waste water power has been utilized at the peak of the load at the time when power is most valuable. The total output of the water power during the past year was over 90 per cent. of the possible output. When operating by steam, the engines have been run at an economical load, the advantages of the storage battery being nearly, if not quite, as great in connection with the operation of the steam plant as of the water plant. For example, during October, 1896, and during October, 1897, the plant was operated entirely by steam. In 1896 the battery had not been installed. The coal bill for October, 1896, without battery, was $4,300. For the corresponding month in 1897, the batteries having been installed, the coal bill fell to $2,600, notwithstanding the fact that the output of the plant had increased during the year more than 15 per cent.

The regulation of the system is much better with the battery than it could possibly be without it, and the service is much more reliable. The interlocking of the battery with the alternating current by means of the rotary transformers makes the battery act as a regulator on the alternating current system as well as on the direct. During the daytime on Sundays the entire load, both direct and alternating, can be carried by the storage battery. The battery has frequently been allowed to feed the alternating system through the rotaries.

The transformer and battery station is operated by three men—the superintendent (an expert in care of batteries) and two switchboard attendants. The labor in caring for a station of this output is a minimum.

The system could, of course, be operated with direct-current generators connected to alternating current motors. This would necessitate in the place of each 250 kw. transformer one 300-kw. motor direct connected to two 125-kw. generators, and a smaller motor direct connected to two boosters. The result would be a much greater investment in machinery, much greater floor space occupied, greater complication and expense of operation, and a lower efficiency.

In summing up, Prof. Robb said that his Hartford experience has convinced him that the most satisfactory method of supplying electric energy over a considerable area is from a central power station generating alternating current; the current being distributed to rotary and battery sub station of high voltage, and the energy locally distributed on the 3-wire, direct-current system, except in outlying districts, where it will be found more advantageous to distribute on the alternating current system.

In the discussion which followed the reading of Prof. Robb's paper Mr. E. A. Leslie said that during the past winter his company has operated two 2-phase rotary transformers of 200 kw. each, at a frequency of 60 cycles, and that the experience with the same has been entirely successful. Mr. Leslie, in referring to the load line in Hartford, stated that he was surprised that on Saturday night the Hartford peak should be lower than on ordinary nights; the conditions in New York City, uptown, are just the reverse, the peak on Saturday night running beyond anything like that of the ordinary week day load, and at the same time broadening up. In reply to a question, Prof. Robb said that the copper strips that had been applied to the field of the rotary prevented change in the magnetization of the field magnets; any tendency to change was thereby immediately dampened, thus obviating pumping. Pumping after starting increases progressively, and by means of the strip the pumping is checked at the outset.

In reply to a question as to the manner of obtaining regulation on each side of the system, using two wire rotaries with a storage battery, Prof. Robb said that the system is very nearly perfectly balanced as regards feeders at full load. At times of low load the feeders are simply pulled out of one side of the system until the balance is obtained at the junction boxes.

Mr. C. L. Edgar stated that in Boston, where they have five or six large storage batteries, some of which are located so far out from the 3 wire generating station as to be difficult to charge, the installation of an alternator has been discussed seriously during the past year. The plan is first to transmit high tension current to the various battery substations and then by means of rotary converters turn it into direct current. The question of obtaining the high tension current appears to resolve itself into putting in single-phase alternating dynamos run by engines, or dynamos generating both alternating and direct current, or taking the current from the 3-wire system and transforming it by means of rotaries into high tension, raising the voltage by static transformers and carrying it about the city.

Prof. Robb added the further information, concerning the third rotary transformer installed, that it differs from the others in that its

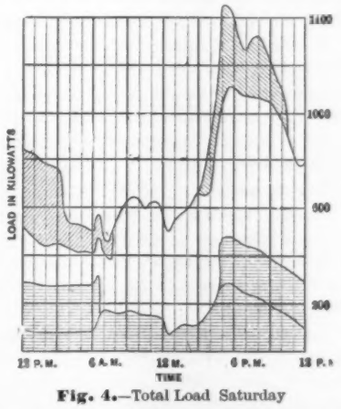


Fig. 4.—Total Load Saturday

shaft is continued out beyond the bearings, so that it can be belted to one of the engines and used for generating direct or alternating current.

In answer to a question as to the experience at Hartford with series alternating inclosed arc lamps, Prof. Robb stated that a year ago a 30-light constant current transformer was installed for operating such lights. The experience was so satisfactory and the lights ran so steadily that during the year six 100 light transformers were gradually installed and at the present time are all running. Operating under these conditions, each lamp is supplied directly with 400 watts of alternating current, this being 150 watts less than formerly required to operate the 315 watt direct current lamps, the direct current lamps being operated from series arc dynamos belted to a large synchronous motor. Alternating current series arc lamps have been in continuous operation since they were installed, and work with perfect satisfaction. The arc transformers are operated from sub-stations consisting of a house 10 feet square on a piece of land in an out-of-the-way place behind some house or factory, in which are put two 100-light transformers. The transformers require no attention from the time they are started until they are stopped. The inspector of the district turns the lights on and off, and is supposed to visit the house once during the night.

There are Bristol recording ammeters in each sub-station, and when the inspector starts the service he connects the ammeter on one of the transformers, and when he makes his inspection he transfers it, and the swing of the needle indicates that he has been there. The line on the recording ammeter is absolutely uniform, there not being a hair's breadth variation from 6¼ amperes from night to morning. The transformers are practically automatic and are made with two stationary coils and two movable coils balanced on knife edges; all the motion is the slight motion at the knife edge when the transformer is started and stopped.

Mr. Wagner stated that in St. Louis from 2,300 to 2,600 series alternating arc lights are in constant nightly operation, the lamps being operated from the various circuits by transformers placed in the sub stations. While the system is not as absolutely automatic in its operation as the system at Hartford, nevertheless but one attendant is necessary in the sub-station for an output composed of arc and incandescent lamps and power.

In answer to a question as to the relative photometric value of the open and inclosed arc lamps, Prof. Robb stated that the mean spherical candle power of the open arc is greater, for the same energy consumed; but in the case of lights 200 or 300 feet apart, the difference in the illumination in the street does not vary much as between the two lamps. In Hartford the fact that the alternating current lamp does not give for the same watts as much light as the direct current lamps is admitted, and about 25 per cent. more power is supplied; nevertheless the station output per lamp is less in the ratio of 550 to 410 or 415 watts than formerly with open arcs. The city contract calls for 315 watts per lamp, 1,200-candle power standard, and 400 watts are supplied.

The Manufacture of Graphite.

In a lecture on the subject named in the heading, delivered by Mr. E. G. Acheson, of Niagara Falls, N. Y., before the Franklin Institute, the speaker said:

Very early in my experiments on the manufacture of carborundum I noticed that graphite occasionally formed in the portion of the furnace charge lying next to the cylinder of granular amorphous carbon, which passed through the center of the furnace, and which became heated to an extremely high temperature, by the passage of a heavy electric current, and around which the charge was placed to receive the heat necessary for the formation of carborundum. Also that when ordinary bituminous coal coke was used to form the core quite a large amount of it was converted into graphite, whereas when petroleum coke was used very little of it was made graphitic.

By a careful study of these formations it was found that the graphite formed outside of and surrounding the core was produced by the decomposition of the carborundum, which is, chemically, a carbide of silicon, and, by induction from a number of known facts, that that formed within the core was also produced from a similar decomposition of carbides, which were created by the chemical union of the carbon of the core with its contained impurities. The facts from which I have drawn this conclusion are:

1. Comparatively pure petroleum coke produces practically no graphite.

2. Impure bituminous coal coke produces large quantities.

3. The larger the known percentage of impurities in the bituminous coal coke the greater the amount produced.

4. That only a part of the carbon of the core is converted into graphite. This not being increased, even by repeated use of the same grains in successive carborundum furnaces.

The graphite formed by the destruction of carborundum is remarkable in that it retains the form of the crystal of carborundum from which it is derived. It has, however, less than one-third the weight of carborundum and possesses the characteristic metallic gray color of natural graphite, but in size and form it so closely resembles the original crystal as to be, in fact, its skeleton pseudomorph in graphite. The graphite formed in the core is usually not so well defined, or distinct, as in that from carborundum, most of it being disseminated through the body of the individual grains in which it is found, the amount contained in any one grain varying with the percentage of impurity originally present. In some instances the entire mass of the grain is converted into beautiful graphite, this occurring, I think, in cases where the grain is largely composed of slate, and it sometimes happens that one half of the grain is completely converted, while the remainder is changed but little.

These two seemingly distinct methods of producing graphite from carborundum and from coke are, in fact, identically the same; the first step in each is the formation of a carbide, the second its destruction. In making carborundum, silica and coke are mixed in the correct proportions to produce a true carbide, when heated in the electric furnace, without an excess of either constituent. In making this mixture account is taken of the impurities contained in the coke and the silica reduced proportionately. In the case of the core there is a natural mixture that produces a carbide from a portion of the carbon. The carbides formed under both of these conditions decompose when heated to a certain temperature above that at which they were formed.

This method of manufacturing graphite I would define as consisting in heating carbon, in association with one or more oxides, to a temperature sufficiently high to cause a chemical reaction between the constituents, and then continuing the heating until the combined carbon separates in the free state. It is not, however, limited to the use of oxides, as pure metals, their sulphides and other salts may be used; but for various reasons the oxides are to be preferred.

Theory of Formation.—All of the methods of manufacture thus far known contain the same underlying, fundamental principle. Each of the six methods described by Muir, as well as my own method, contains as a part of the process the expulsion or liberation of the carbon from a chemical association with one or more elements, and this occurs under conditions unfavorable to, or absolutely prohibitive of, its reassociation with the same or other elements. It is cast out, free to take unto itself such physical or other properties as we must assume properly belong to it in the free state when formed under normal conditions. It has been shown by Moissan that when subjected to great pressure, at the moment of separation from cast iron, carbon has those distinctive characteristics that cause it to be called diamond, while Scheele showed in 1778 that the same carbon, separating from the iron without pressure, takes the graphitic form. Amorphous carbon, the third allotropic form, never occurs pure and is invariably produced from carbon held in chemical association with other elements under conditions favorable to free chemical action between it and other elements.

The production of graphite by Rose's method—heating a diamond bedded in charcoal to the melting point of cast iron—is a beautiful illustration of the return of a body under strain to the form it takes under normal conditions. It will be noted that the diamond was heated to the temperature at which it is known to form, as shown by Moissan's experiments; also that it was fairly well protected from chemical action.

The statement in the "Encyclopædia Britannica" that both diamond and amorphous carbon are converted into graphite when heated by a powerful electric current is very commonly held, indeed I might say universally, although Berthelot concluded from his investigations that heat alone is with influence on carbon—that is to say, graphite is not changed to amorphous carbon, nor the amorphous to graphite, when heated to whiteness in an atmosphere of hydrogen or chlorine. That diamond will change to graphite when protected from chemical influences under the influences of high temperature is undoubtedly true, and, indeed, is what might be expected from other known facts; but that pure amorphous carbon will change to graphite as the simple result of heating is not proven, and certainly it does not occur at or below the temperature necessary for the transformation of the carbon in a carbide to graphite.

From the facts in hand I have deduced the following theory:

1. Graphite is the form which carbon assumes when freed from chemical associations under conditions of low pressure and protection from chemical influence.

2. Diamond is the form which carbon assumes when freed from chemical associations under conditions of high pressure and protection from chemical influence. And, by inference,

3. Amorphous carbon is the form which carbon assumes when freed from chemical associations under conditions of low or high pressure and exposure to chemical influence.

This theory does not, however, account for all of the observed facts, and must be supplemented by the hypothesis that catalysis occurs, under certain conditions, during the transformation of amorphous into graphitic carbon. The amount of graphite produced in the core of a carborundum furnace and also in graphite articles I have made is much too great to be accounted for by the theory that it is formed by the dissolution of the fixed carbides formed by the contained impurities and carbon sufficient to satisfy the chemical formula. The most probable and satisfactory explanation is that a catalytic action occurs—a progressive formation and dissolution of carbides. The temperature being

much above the point of volatilization of silica and all other possible impurities, a rapid dissipation of the active agents takes place and is completed in this case before the conversion of all of the amorphous carbon can occur.

Commercial Manufacture.—As to the result of my investigations and deductions, I think the only commercial way to make graphite is by breaking up a carbide by the action of heat. The carbon should be freed from chemical combination by what might be termed the evaporation of its associated elementary substances. I have secured patents covering this method, and these have been made the basis for the organization of an incorporated company bearing the name Acheson Graphite Company. The company have now under way the erection of works at Niagara Falls, where the necessary electric current will be obtained from the Niagara Falls Power Company.

Several distinct forms of the product will be produced. One consists of forms or articles made out of amorphous carbon with the desired amount of impurity added thereto, which will afterward be heated in an electric furnace and converted, more or less, into graphite. I have been carrying on this line of manufacture for a year or more, using the furnaces of the Carborundum Company to produce the graphitization, the articles having first been made by the arc light carbon manufacturers.

Over 200,000 carbon electrodes, measuring 15 inches in length, with about 1 inch cross sectional area, were made for use in the Castner alkali process, nearly one half of them having been shipped to Europe, to be used for this work in England and Germany. The life or efficiency of these graphitized electrodes is many times that of the same electrodes ungraphitized. I have also graphitized some tons of carbon plates, to be used in making dynamo and motor brushes, and a large variety of odd forms and sizes for divers purposes.

Another product—the one which will probably be of greatest importance—is an intimate mixture of pure amorphous carbon and graphite in fine powder. This will be put on the market for paint and foundry facing, and, as it has been formed at an extremely high temperature, it is quite pure, and possesses all of the qualities desirable for the purposes for which it is intended.

It is not the present intention of the Company to enter into the manufacture of their product into finished form for the general market, but rather to encourage those who are now engaged in making up the natural graphite into articles of commerce to become buyers of their material, substituting it for that now used.

The Company's plans now being carried out provide for the erection of a brick and iron building, 100 by 50 feet, on a plot of ground in Block No. 8 of the Niagara Falls Power Company's lands (adjoining the works of the Carborundum Company). Therein they will erect machinery for reducing coke to grains of the desired size, an electric furnace through which the prepared grains will pass in a continuous stream, a pulverizer for reducing the grains as received from the furnace and a scalping sieve through which the product from the pulverizer will pass, that particles exceeding the $\frac{1}{100}$-inch diameter may be removed. The final flour or powder will contain an amount of pure graphite proportionate to the percentage of impurities in the original coke. It is quite possible that, instead of using high grade, marketable coke, the fine refuse from the coke ovens, which is at present a waste material, will be utilized in the manufacture of this product.

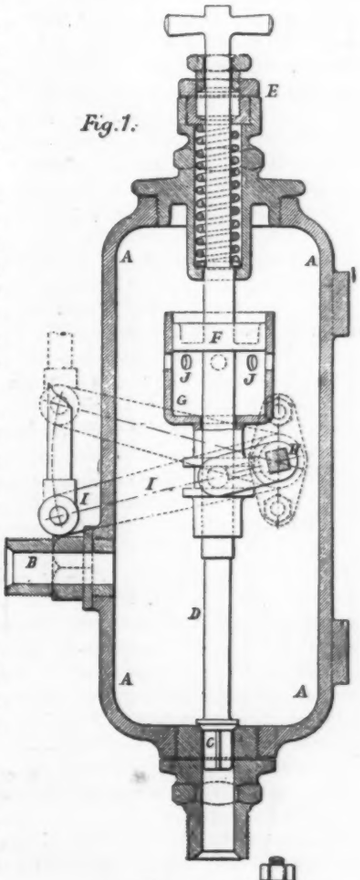
In this connection I would call attention to the need of a specific name for the new product. Artificial, as applied to a product chemically and physically identical with that made by nature is not pleasing; it conveys the impression that, failing to produce the real thing, a cheap imitation, a sham, is being palmed off as the genuine article. Not even the Century Dictionary's definition of artificial, as "made or contrived by art, or by human skill and labor; opposed to nature," is sufficient to banish this feeling; for, after all, in the particular case in hand, being ignorant of the exact methods pursued by nature, we may be simply forcing her to reveal her methods, to the final results of which we neither add nor subtract one jot or tittle. The same objections may be made to the expression artificial manufacture of graphite, for we may not be sure that the process forced upon her is not identical with that of her own selection. Manufactured graphite would be quite appropriate were it not for the fact that it is popularly applied to articles made of graphite.

It may not detract from the general interest in this subject to call attention in closing to the fact that graphite, first shown to be an elementary body, an allotropic form of carbon, in the first year of the nineteenth century, is in this, the last year, made to order in great quantities, and that it will before the close of the century become an article of ordinary commerce in its new form. Perhaps it will take its place as the primitive form of carbon—the one it assumes under normal conditions.

Steam Traps for Very High Pressures.

Engineering says that the case of a steam receiver receiving condensation from a high pressure steam main, and which has to be trapped in some way, brings out the very onerous conditions under which such a steam trap has to work. The very high steam pressure (say 300 pounds) precludes at once any kind of "float" device for operating the valve of the trap, because no hollow float will stand such a pressure, and any kind of solid float with counterbalanced weight complicates the device and increases its bulk. The expansion system of trap also presents difficulties on account of the very high temperature of the steam (419° F.) and also the varying temperature.

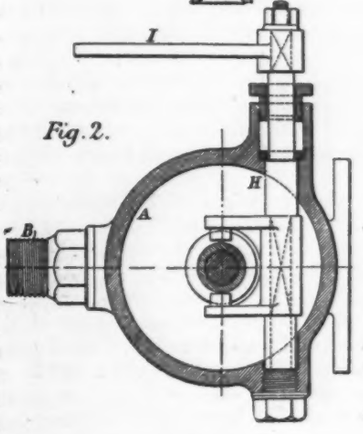
Fig. 1.



In a modern engine, particularly such as are employed in Her Majesty's Navy, the pressure may vary anything between 100 pounds and 300 pounds, and the temperature of the condensation vary in proportion, yet the trap must be able to discharge the water of condensation directly accumulated, and especially to discharge any water arising from "priming." The trap must also be perfectly sound in the valve, so that, when there is no condensation or priming to be dealt with it will be absolutely steam-tight. The apparatus must further be characterized by great positiveness of action, or it is entirely useless, if not worse. It must be compact in form and mechanically simple, so as to be easily understood and kept in order.

In considering the subject to arrive at the best mechanical solution of it, Mr. John J. Royle, of Dalham Engineering Works, Great Bridgewater street, Manchester, decided to make an entire departure, and employ a principle in the operation of the trap which heretofore, he believes, has not been used, and which may be stated as follows:

Fig. 2.



Given some kind of receiver or vessel into which the condensation can flow. At the bottom of that receiver is a valve with a long spindle, passing through a gland at the top end, putting the valve partially in equilibrium. On the spindle is a piston, and around the piston, and capable of sliding up and down the valve spindle is a cylinder. This cylinder is given a reciprocating motion on the spindle from any outside source, and for that purpose a lever is provided by which the motion can be applied. The reciprocating cylinder inside the receiver is so arranged in connection with the piston (the piston being also made a slack fit) that when working in dry steam the reciprocation will go on indefinitely without disturbing the valve owing to the slip of the piston in the cylinder, but the moment condensation overflows the cylinder and interposes a solid body (water) between the end of the cylinder and the piston, the next reciprocation of the cylinder lifts the

piston bodily, opens the valve, and discharges the water of condensation or priming, as the case may be.

The piston is made a slack fit, as above described, so that the water interposed between the cylinder and the piston, if not replenished in about two strokes, leaks out, and the valve resumes its stationary position; but if the cylinder is overflowed stroke by stroke, as might be the case if there was priming, then the lifting goes on until all the water is discharged. Such a mechanical device is positive in its action, in that the working of it does not depend on any delicate float mechanism nor temperature contrivances. It discharges the condensation instantly as formed, without regard to temperature, and is simple in its construction.

The accompanying engraving is a view of a steam trap or "condensation and priming relief valve" (as it would, perhaps, be more properly called), in which Fig. 1 is a vertical section and Fig. 2 a plan. In all the views *A* is the casing, having an inlet *B* for receiving the water of condensation. *C* is the main valve formed on the end of the spindle *D* passing through the stuffing box or gland *E*, by which it is put partially into equilibrium. *F* is the piston formed on the spindle, *G* a cylinder to which is given a reciprocating motion from the outside by means of the horizontal rocking spindle *H* and lever *I*. As before mentioned, the piston *F* is made a slack fit in the cylinder *G*, and a series of holes *J* are formed in the cylinder to allow the water of condensation free access to the cylinder at certain times of the movement of the cylinder. In the figure the cylinder is shown at its lowest point in the stroke, and the holes in the cylinder would pass the piston at about half stroke, or when the lever *I* reaches its horizontal position. For the remainder of the stroke it is obvious that the entrapped steam would lift the piston were it not for the leakage between the cylinder and the piston. The piston is made with such a degree of slackness that it will pass freely in the cylinder when operating under steam only, but as soon as water of condensation or priming finds its way into the casing *A* and overflows the cylinder through the holes *J*, and a solid substance (water) is thus interposed between the cylinder and the piston, at the next movement the piston will be lifted, and also the valve *C*, so discharging the condensation.

This "lifting," as above described, would go on continuously, except that the leak between the cylinder and the piston presently brings the valve to a state of rest, unless, of course, there is such an amount of condensation that the cylinder is overflowed stroke by stroke, in which case the lifting would go on continuously.

A steam trap, or priming relief valve, constructed in this way has been in use for some time, and has been the subject of very exhaustive trials at all steam pressures from 20 pounds up to 300 pounds, and has been found to work perfectly, discharging the condensation instantly it is formed, and, what is also of equal importance, giving a perfectly sound valve free from leakage of steam when there is no condensation to be discharged.

With regard to the operating of the lever *I*, this ought to interpose no difficulties, as it may be driven from any reciprocating part, or from any pump that may be handy, and as it takes little or no power to drive it, it need not interfere with any other mechanism, and the positiveness given to the whole appliance by this method of operating from the outside is worth while making the connection.

Bueb's Process of Extracting Cyanogen from Coal Gas.

On May 30th, U. S. Letters Patent (No. 625,964), were issued to Mr. Julius Bueb, a resident of Dessau, Germany, for new and useful improvements in the extraction of cyanogen from coal gas. Using the words of the specification:

This invention relates to the extraction of cyanogen from coal gas by reactions already known and described—for example, in the specification of Letters Patent of Great Britain, No. 15,164, of 1887, and in German Letters Patent, No. 41,930, granted to Oscar Knublauch—according to which cyanogen is separated from coal gas in the form of a double salt by means of alkalies and iron. Hitherto endeavors to carry out these reactions have been directed to obtaining the salts in the form of a solution, because otherwise the purifying apparatus would become clogged, which would interfere considerably with the practical working. In dealing with the salts in the form of a solution, however, with a view to their ultimate utilization, the process was not satisfactory, owing to the large quantities of liquid to be dealt with.

The object of the present invention is to overcome the aforesaid objections by conducting the process so that insoluble products are formed and separate from the gas before it passes to the ammonia scrubbers. To effect this, there is arranged between the cooler or tar separator and the ammonia scrubber a chamber containing a highly concentrated solution of an iron salt. The highly concentrated iron salt solution, with the assistance of the ammonia, which at this stage is present in the gas, compels the whole of the cyanogen contained in the gas to separate in the form of an insoluble precipitate. This chamber practically acts as a filter by which the insoluble salts formed are separated, so that they do not pass to the scrubbers. By using a solution of the soluble salt of iron of sufficient concentration practically all of the cyanogen present will be obtained in the precipitate.

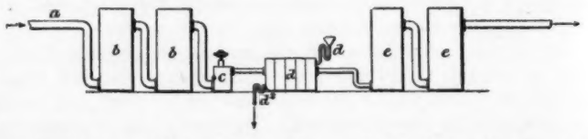
If the soluble salt of iron be not of such concentration as to cause the whole of the cyanogen to be obtained in the precipitate, any double salt of cyanogen which may still be left in the dissolved condition may if desired be brought to the insoluble state simply by boiling and without any other addition of chemicals. The degree of concentration of the iron salt solution employed may vary within wide limits, but should under no circumstances be so low as to yield the double salt or the main part thereof in a dissolved form. In carrying out this process in practice a solution of a concentration of from 10 to 20 per cent. has given satisfactory results.

Any salt of iron may be used, but a chloride or sulphate of iron is preferable. The reaction which takes place is similar to that described in Knublauch's patents, and may be illustrated by the following formula:

$$6(NH_4)CN - 2FeSO_4 = 2[(NH_4)_2SO_4] - Fe_2(NH_4)_2(CN)_6.$$

In the accompanying drawing I have indicated in general outline an apparatus suitable for carrying out the process.

Referring to the drawing, the gas is delivered to the pipe *a* and passes through the coolers *b* and thence to the tar separator *c*, these being of



any well known construction. The cooled and tar freed gas then passes through the vessel *d*, in which the cyanogen is precipitated in the form of an insoluble mud. This vessel is filled with a concentrated iron salt solution, the solution being admitted through the feeding funnel d^1, while the precipitated mud, together with the mother liquor, is led off by the pipe d^2. The gas freed from its cyanogen is then passed through the ammonia scrubbers *e e*, of any well known kind, and from thence through a pipe, which may lead to the sulphur separators or other desired apparatus. It will thus be seen that the cyanogen is precipitated out of the gas before the latter passes through the ammonia scrubbers and the recovery of the cyanogen is separate from that of the ammonia, although a portion of the ammonia is precipitated with the cyanogen in the form of a mud of insoluble double salt.

The ammonia which has not entered into reaction passes off with the gas into the ammonia scrubber proper, and any chemical combination tending to the formation of mud and the clogging of the scrubbers is avoided. In practice it is preferred to employ two or more chambers or preliminary purifiers containing the iron salt solution, so that by means of suitably disposed valves and connecting pipes either can, according to requirements, be connected with or disconnected from the system, and when a certain quantity of mud has settled down in one chamber such chamber can be disconnected from the system, while another chamber charged with iron salt solution is connected therewith. The contents of the disconnected chamber, after being discharged therefrom, may be boiled and then the dissolved part be separated from the undissolved part and marketable ammonia salt may be extracted from the former direct.

Although salts of iron have alone been referred to above, other metal salts may, if desired, be used; but I consider only the salts of iron to be at present of any value economically, and although I have described the use of a separate chamber for the reception of the soluble salts of iron it will be evident that the first compartment, or first two or more compartments of the scrubber, can be used in place of such separate chamber where the scrubber is of a nature to render this practicable—for example, the horizontal scrubbers with rotating bodies alternately dipping into liquid and presenting their wetted surfaces to the gas. In this case the first one, two or more of the compartments will contain the soluble salts of iron in place of water. In this case care must be taken that the solution of salts of iron is kept separate from the water in the ammonia separating part of the scrubber.

The claim of the inventor is: The herein described process of separating the cyanogen from gases of dry distillation containing ammonia in excess of cyanogen, which consists in treating such gases with a con-

centrated solution of a metallic salt, thereby precipitating all the cyanogen and part of the ammonia in the form of an insoluble double compound, and leaving the greater part of the ammonia with the gas.

Transformers: Iron Loss—Its Increase—The Remedy.

[A paper read by MR. G. W. HUBLEY at the last meeting of the National Electric Light Association.]

Attention to the subject of transformers, meters, etc., in the alternating field of electrical work has been very general, and much has been written and many have been the discussions on these subjects.

The necessity of inspection, testing, etc., of all meters in service, at regular periods, has been conceded as an economic necessity by central stations, as well as being recommended by the manufacturers; yet such has not been true about transformers, and this important and essential apparatus has been most seriously neglected, owing to the impression and erroneously accepted fact that its characteristics are in a measure unchangeable. The transformer passes into its work and no further attention is given, except in cases of absolute failure by "burnout" or other extreme condition interfering with its service.

It is, however, a generally accepted fact that there comes a time in the history of transformers when their efficiency and profit earning can be greatly increased by means of substitution or change of characteristics.

It is the latter plan that the writer shall treat as the subject matter of this paper.

No other question has more commercial significance in the operation of a transformer system, from a central station standpoint of view, than the constant iron losses of transformers in service. Yet the question has had, probably, less careful and systematic investigation than any other detail of the alternating system, owing, doubtless, to the fact that the great and increasing losses in this direction have not been fully appreciated until the past few years.

It must be admitted that great improvement has been made in this direction by the manufacturers, with a view of reducing this iron loss to its present low figure; but the question of "fatigue" is of greater importance than the initial conditions.

All data, tests, etc., as given in this paper have been carefully and accurately compiled from actual facts and conditions as they exist in the central station with which the writer is identified and the company whom he represents as delegate to your convention.

It has been found in practice that transformers having initially low iron losses (within limits of specifications), after being placed in service would show most decided increase—in most cases over 100 per cent. increase, and in exceptional cases as high as 300 to 400 per cent. increase, within very short periods of service under normal conditions.

In fact, the "fatigue" feature or large increase of iron losses in many transformers made their further use commercially prohibitive.

To illustrate the conditions of the question, the writer gives the following records of a few tests on various sizes of transformers, showing the increase of iron losses during periods of service:

Capacity.	Initial Test.		Second Test.		Per Cent. Increase.	Third Test.		Per Cent. Increase.	Total Per Cent. Increase.
	Watts.	Per Cent.	Watts.	Per Cent.		Watts.	Per Cent.		
500	36	7.2	65	13	80.6	75	15	15.4	108.4
1,000	58	5 8	75	7.5	29.3	100	10	33⅓	72.4
1,500	60	4	97	6 5	61⅔	120	8	23.7	100
2,000	75	3¾	125	6.1	66⅔	145	7¼	16	93.4
3,000	80	2⅔	133	4 4	66¼	150	5	12 8	87½
4,000	109	2.7	175	4¼	60.6	185	4.6	5.7	69 7
5,000	120	2.4	140	2 8	16⅔	145	2.5	3.6	20.8
7,500	145	1.9	167	2.2	15.1	190	2.6	13.8	31
10,000	190	1.9	250	2 5	31 6	....	....	....	31.6
12,500	218	1.7	238	1.9	9.1	315	2.5	32.4	44.5
25,000	323	1.3	530	2.1	64.1	....	....	....	64.1

The above tests represent transformers of various types of manufacture during the years 1894, 1895 and 1896, and cover periods of service from 1894 to 1899. The actual services between tests vary from periods of six months to two years, but in most cases are made each consecutive year.

During the past several years the writer has carefully studied this question in all of its phases, as it relates to the practical conditions as met with in everyday station work.

Only within the past year have manufacturers been willing to recognize or accept the adopted specifications on transformers of the central station. In fact, they would not guarantee initial limits or qualify limits of deterioration of their transformers in service. The writer adopted transformer specifications during the year 1895, in which limits of iron loss were fully 50 per cent. greater than those of present day specifications.

The following specification limits were adopted January 1, 1899, and all transformers must pass under initial conditions within specified limits or be rejected:

Capacity.	Iron Loss.		Regulation.
500	35 watts.	7 per cent.	3 per cent.
600	36 "	6 "	3 "
1,000	45 "	4.50 "	3 "
1,250	45 "	3.60 "	3 "
1,500	51 "	3.40 "	3 "
2,000	60 "	3 "	3 "
2,500	65 "	2.60 "	2.50 "
3,000	75 "	2.50 "	2.50 "
3,750	90 "	2.40 "	2.50 "
4,000	90 "	2.25 "	2.50 "
5,000	110 "	2.20 "	2.25 "
6,000	120 "	2 "	2.25 "
6,250	125 "	2 "	2 "
7,500	150 "	2 "	2 "
10,000	175 "	1.75 "	2 "
12,500	200 "	1.60 "	2 "
15,000	210 "	1.40 "	2 "
18,750	225 "	1.20 "	2 "
20,000	240 "	1.20 "	2 "
25,000	275 "	1.10 "	2 "
30,000	300 "	1 "	2 "
37,500	375 "	1 "	2 "
50,000	500 "	1 "	2 "

"Insulation test to be made by a series of make-and-break contacts and one prolonged contact, as follows:

1. Between primary and secondary coils 6,000 volts A. C.
2. Between primary coil and core..... 6,000 " "
3. Between secondary coil and core..... 1,000 " "

"Temperature test measured by thermometers placed in mercury cups in core of transformers. Increase above surrounding atmosphere on full load test of eight hours' duration must not exceed 60° C.

"*Fatigue.*—Iron loss must not exceed 10 per cent. increase above limits, as specified, within period of two years' service.

"*Overload.*—Transformers must be guaranteed to stand overload of 25 per cent. above rated capacity for duration of two hours, with temperature increase not to exceed 60° C. above surrounding atmosphere.

"*General Guarantee.*—Transformers must be guaranteed for two years' service against burn out from any cause (including lightning), providing same are under normal conditions of service.

"*Remarks.*—The above specifications do not contemplate the use of oil in transformers.

"In case of failure of transformers furnished under specifications, all expenses of rejection shall be borne by the manufacturer."

It has been the practice of the writer to make initial tests on all transformers when received, and their acceptance or rejection has been strictly governed by limits as set forth in specifications, and to repeat this test under similar conditions as often as opportunity permits, *i. e.*, at all times when transformers were brought into station from service.

A careful and permanent record of all such tests is kept as they apply to each individual transformer.

It is probably unnecessary to state what the iron losses and their increase mean to the average central station, except to call attention to the fact that existing iron losses in transformers approximate from 50 to 70 per cent. of output of the average alternating station.

Let us consider an average case, by way of illustration, to compare the probable useful current supplied with the iron loss or waste current per year required at installation.

For example, 1,000 watt transformer having initial iron loss of 58 watts (5.8 per cent.), having been under service during a period of two years, records iron loss of 100 watts (10 per cent.), or fatigue of 72.4 per cent. We will make the liberal assumption that this transformer averages full load for five hours per day during 300 days in the year; therefore, initially, the transformer will require during the year "useful current" 1,500 kw., and during the year "iron loss" current 508 kw., or a total of 2,008 kw. for service.

It will be noted that "useful" current is 74.7 per cent, and "iron

loss" current 25.3 per cent., or "iron loss" current amounts to 33.9 per cent. of current used usefully.

Consider similar service and conditions on this transformer after "iron loss" has increased 72.4 per cent., and we find that it will require during the year "useful current" 1,500 kw. and during the year "iron loss" current 876 kw., or a total of 2,376 kw., for service. It will be noted now that "useful current" is 63.1 per cent. and "iron loss" current is 36.9 per cent., or "iron loss" current amounts to 58.4 per cent. of current used usefully.

The question naturally arose, What was to be done with transformers having such abnormal iron loss?—it being out of the question to scrap these, or to obtain others by the expensive method of exchange for new "present day" transformers, under plan suggested by manufacturers, who willingly proposed to remedy this condition.

The writer began some experiments in the line of treatment of iron of old transformers, and after some time obtained most successful and gratifying results in this direction. However, no claims can be made at present writing of the permanency or resultant action that may occur by the methods adopted, as only time test will determine this point, but it is reasonable to expect the change made in the character of the iron in transformers so treated will prove itself more nearly constant and permanent than it was initially.

The method of treatment adopted is one of annealing the iron of transformers which show abnormal loss. The results have proven most gratifying, in all cases reducing the losses to their initial (or even better) records, and in no manner affecting other requisite qualifications of the transformer.

The work can be done readily and at an admissible low cost per unit, to make the work commercially within bounds, and a far better paying investment than any other plan that has been suggested or followed with the same object in view. In other words, it restores the transformer system, whether transformers are new or old type, to their original, or even better, condition, as far as iron losses are concerned.

A table is herewith presented, compiled from records of experimental work on transformers taken from service, without selection, in the regular course of business of station. It therefore represents actual practical conditions. Some idiosyncracies are shown that are interesting. From this table practically correct deductions may be made as to possibilities of reduction of constant iron losses and the advantages to be derived therefrom :

Capacity Watts.	Initial Test.		Test Before Treatment.		Increase Iron Loss.	Test After Treatment.		Decrease Iron Loss.		K. W. Saving per Year.
	Watts.	Per Cent.	Watts.	Per Cent.	Per Cent.	Watts.	Per Cent.	Watts.	Per Cent.	
500	40	8	64	12.8	60	42	8.46	22	34.37	102.7
1,000	60	6	88	8.8	46⅔	59	5.90	29	32.95	254.0
2,000	84	4 1	150	7.5	78.6	117	5.85	33	22.00	289.1
3,000	108	3.6	139	4.6	28.7	97	3.23	42	30.21	367.9
7,500	140	1.9	167	2.2	19.3	135	1.80	32	19.10	280.3
10,000	175	1¾	240	2.4	27.1	160	1.60	80	33.33	700.8
25,000	350	1.4	530	2.1	51.5	323	1.29	207	39.06	2,829.5

This table represents the average results of tests of transformers of capacities as noted.

Type (actual service of life of transformers), was not taken into consideration, as it is the object of the writer to present the actual practical working condition of the average central station. The station of which the writer is in charge has kept pace with the times in taking advantage of all improvements of modern apparatus as well as modern methods of operation; and, moreover, gained decided advantage by complete change of all transformers to those of modern type, dating from the year 1894, when change was made from 1,000 to 2,000 volt system, and since such time has made one extensive substitution of about 50 per cent. of these transformers to others of latest type and manufacture.

The cost of "annealing treatment," as practiced, can be accomplished at so low a cost per kw. that it insures its success. The plan to reduce and regulate the increased iron losses in transformers is both simple and practical.

The following data of detail costs per kw. capacity have been computed from records of actual costs during period of experimental work :

	Preparation.	Annealing.	Assembling.	Testing.	Total Cost.
Average cost per kw.....	.092	.106	.618	.084	.90

However, the above costs cannot be taken as criterion, as such only represent results of experimental work on transformers of various manufacture, type and capacity, and naturally these costs as given are considerably higher than will be found in practice. The average costs per unit will vary greatly under different local conditions, owing to the wide margin of variation of costs in transformers of small and large capacity, as the item of cost per unit does not vary proportionally with the capacity.

It can be liberally approximated that complete costs of "annealing treatment" will vary between 22 cents per kw. on 25 kw. size to $2.20 per kw. on ½-kw. size of transformer.

The advantages of the "annealing treatment" of iron of transformers will be more fully appreciated by facts deduced from foregoing data, as set forth in the following table :

Capacity. Watts.	Loss per Year. Kilowatts.		Saving per Year. Kilowatts.	Saving per Year at 2c. per Kilowatt.	Estimate of Complete Cost of Treatment.	Interest per Year, per Cent.
	Before Treatment.	After Treatment.				
500	560.64	367.92	192.7	3.85	1.10	350
1,000	770.88	516.84	254.0	5.08	1.85	275
2,000	1,314.00	1,024.92	281.1	5.78	2 60	222
3,000	1,217.64	849.72	367.9	7.34	3 60	204
7,500	1,462.90	1,182.60	280.3	5 60	4 50	125
10,000	2,102 40	1,401.60	700.8	14.00	5.00	280
25,000	4,642.80	1,813.30	2,829.5	56.59	5.50	1,029

It will be noted that the gains by actual saving to be obtained through adopted methods of treatment of iron at the extremely low cost per unit make the system appeal for a place in the economic field of central station operation more strongly than any other measure in this direction.

By the most conservative estimate the average central station can reduce and regulate within reasonable limits this all important feature of loss wherever transformers are in service to 50 per cent. of their present records, and this means not only a saving of 25 to 30 per cent. on yearly cost of fuel, but increased capacity on boilers, engines, dynamos, etc. Hence the reduced fixed charges per unit, higher commercial efficiency of transformer system and consequent increased profits per unit of current sold; and last, but not least important, a periodical inspection, reinsulation and general renewal of all transformers in service, and an absolute control and regulation of their increase of iron losses.

In conclusion, the writer begs the indulgence on the part of readers of this paper for any errors in calculation or omission of data, owing to limited time and attention that have been given in the hasty preparation of this subject.

Advice to Young Civil Engineers.[1]

About this time every year there are several thousand young men in danger of being distracted by a plethora of well-assorted kinds of advice. During four years of nominally hard and really easy work they have struggled to assimilate the masses of diverse information forced upon them at the various mental incubators they attended, and now that this work is done the cold-hearted man of business or the wily lawyer assures them from the college platform that what they have learned is really of trifling importance compared with conscientiousness, honesty, industry and such things, which, for some reason, these graduation orators seem to believe are never inculcated in schools of engineering. Some of these addresses to graduating classes are probably among the saddest oratorical efforts of the year, and it is therefore a pleasure to notice the entirely different kind of advice recently given a graduating class in civil engineering at Cornell, by Mr. Edwin Duryea, Jr., M. Am. Soc. C. E. Through the courtesy of Prof. C. L. Crandall, *The Engineering Record* is able to give the graduating classes of other institutions a summary of Mr. Duryea's remarks before their publication by the Association of Civil Engineers of Cornell. Of course the speaker found it necessary to refer to certain fundamental principles of business success; the nature of his address compelled this, but it was done gracefully, and in the following summary of portions of his remarks the graduates to whom they are addressed are assumed to understand the Golden Rule and to appreciate the fact that it is only in fables the tortoise wins the race.

At the outset it was stated distinctly that success in civil engineering must be sought in the work itself rather than in any outside reward. This was declared to be the true success recognized by successful engineers themselves; the ends sought fully attained by the most

1. From *Engineering Record*.

economical and intelligent use of the resources at hand. "And one thing more—not only that the work shall be done well, but that a successful life shall include a fair or large amount of it and of an important nature; for no matter how well work may be done, unless there has been much of it and it has been of some importance and use, the power and intelligence of a lifetime, at least, as related to engineering work, will have been partially wasted." Since the main success must lie in the work itself, no one should continue in the profession without a strong love for it. Most men must work to earn their livings, and engineers should be thankful they can do so by employment which is a pleasure and not a drudgery to them, and with the necessary living more of a compensation than an end.

One of the worst misfortunes which can occur to a young graduate is to get for his first position an "easy job." For at least the first three or four years he should have to work so hard and so constantly, that hard work becomes a habit with him and a natural condition. The speaker was inclined to believe that the best training in the beginning is afforded by a subordinate position under a conscientious engineer of surveys for railroad location; after getting accustomed to this, almost any other work will seem easy. The observation of *The Engineering Record* is to the effect that a thorough course under one of the old-school railway surveyors will make any other work outside of jail seem an "easy job." This journal, however, does not agree with Mr. Duryea in his statement that the worst position to begin in is one connected with ordinary city engineering, "with its short hours and jealousies, politics and pulls." It is to be feared that his experience has been an unfortunate one; there are many cities in the United States where the hours are long, the work is hard, and duties are discharged conscientiously and with entire freedom from political influences.

An apprenticeship under the city engineer of such a community is decidedly advantageous to any young graduate, as it will frequently bring him into close touch with a wide variety of problems usually hurried over or entirely neglected in his school work.

Civil engineering is popularly supposed to be a precise profession, but is in reality the very opposite. The natural laws are usually so obscured by co-mingling that they cannot be interpreted precisely. The qualities of many of the materials which are to be used are either imperfectly known as yet or very variable. As the premises are never the exact truth, so the conclusions deduced from them can be no more than limits between which the precise truth must lie; and the result to be used must be selected from between these limits by the exercise of judgment. Viewed at its true worth, the strain sheet, which is such an essential part of every bridge design, and is too likely to seem a precise truth and the main feature of the design to a beginner, is merely a basis on which to apply the judgment. It is also based on premises which are more or less arbitrary, and its stresses, in consequence, differ more or less from the exact but always unknown truth. Even should the stresses be exact, the safe strength of the materials, and therefore the resulting structure, is mainly a matter of judgment. Even assuming that both stresses and materials are matters of precise knowledge, the very duty for which the bridge is to be built, the amount of moving load it is to carry and the amount of wind load to be provided for in addition, are matters which can be decided by the judgment only, and that within wide limits.

Similarly all formulas for dams are based on arbitrary assumptions, and eminent engineers differ widely in their choice of such assumptions. The larger engineering questions, as the location and height of the dam necessary to store the desired supply, the proper size of spillway, the choice and treatment of the foundation and of the materials to compose the structure, are all mainly matters of judgment exercised within very broad limits. In the same way the regulation of the size of a city's water supply for its future needs, of the sizes of the sewers to the future run off, in fact all engineering questions, both great and small, can be decided only by the judgment, and the only use which can be made of precise methods of computation is to furnish limits within which the judgment must do its work.

The use of limits is valuable and far reaching; it may even be said that the whole practice of civil engineering is based on it. It will solve many problems in a negative way, as it is frequently sufficient to ascertain whether a structure is strong or efficient enough for a particular use, rather than to ascertain its exact strength or efficiency. Cost estimates can always be made by its use, the limits being wide or narrow to correspond with the experience and judgment possessed. It is always possible to say whether the cost will be nearer $10,000 or $100,000, and in general to name one sum which will certainly be below the cost and another which will as certainly be above it. Since precise computation plays such a relatively unimportant part in the practice of civil engineering, young engineers should not allow themselves to be balked by the lack of theoretically exact methods. Results can generally be secured by approximate methods, or by the rational solution of a simpler substituted case, perhaps unlike that in hand in most ways, but analogous in the one particular which must be investigated. Many things which are strictly true in principle are almost unmeasurable and entirely trivial in effect. Each use has its own limit of permissible error; and if any effect comes below this limit its cause has no place in the particular problem and should be neglected in the calculations.

In any piece of engineering work it is necessary to distinguish sharply between the end sought and the means, and between the primary end and the less important results. The primary end or result in any given case is fixed, but may usually be reached in several ways, the best way in one case being often not the best or safest or cheapest in another. The secondary benefits which may be achieved, however, will vary with the means employed, and will often determine what means shall be selected. The weak point should always be sought. In every scheme outlined, and in every train of connected operations proposed, there is one point less safe or feasible than the others; some one step which limits the safety, speed or cheapness of the whole result, making all the other operations, no matter how perfect in their actions, partly inoperative. The engineer's main duty lies about this weakest point; he should make strong efforts to improve it or bring it above the next weakest, which should then receive his attention. In improving any but the weakest point his efforts may be practically wasted, while in improving the weakest he is advancing the effectiveness of all the others and improving the quality of the result itself. In considering any piece of engineering work, the young engineer should not be satisfied with knowing merely the results which have been achieved. He should endeavor to ascertain how these results have been effected by the different operations and why they are not better or worse; also what features or cost could have been omitted without detracting from the desired results—for simplicity and directness are in themselves virtues, lessening friction, wear, and the chances of error and interruption. In making designs and estimates for strength, time or cost, average conditions or the worst should be assumed. Most underestimates can be elaborately explained away afterward, but the fact remains that the extra time or money is gone, or that the structure has failed to perform its duty; and a man who could have foreseen such excesses would have been a better engineer. It is the unforeseen that always happens, but the better the engineer the less is unforeseen.

The ease and certainty with which an engineering problem can be solved depend as much as anything on the form of its statement. Those which seem unsolvable often become clear and easy when recast in other forms. The form likely to be the clearest is the rational one, following out the train of operations step by step in the order in which they would naturally occur or be developed. An important added advantage in this form is the safeguard thus obtained against the omission of any essential operation, cause or effect. Each feature of a subject should be taken up in this logical order, and, as far as practicable, definitely settled before the next is undertaken.

The usual name given to a scheme for work is organization. By its use wants are foreseen and provided for, useless features lopped off, the duties and relative importance of different parts made apparent, and the whole work made to progress more smoothly and effectively. But important as organization is, it may be overdone. It is, after all, only a tool, and whenever it becomes so cumbersome in its operation as to exert a retarding or expensive effect on the work, its limit of usefulness has been passed. Engineering work is much less amenable to a high state of organization than is the subsequent use of the structures built.

The essence of organization consists in making easy the frequent repetition of the same operation in the same way, and is, therefore, opposed to changes. In constructing engineering works the nature of the operations is constantly and rapidly changing, and each is repeated only a comparatively small number of times, offering no chance for more than a rough and general organization; moreover, many circumstances are sure to arise which could not have been foreseen and prepared for in any practicable scheme.

There are many other features in Mr. Duryea's address which might well be reprinted, but among them all there is probably none more generally applicable and sound than that which is quoted verbatim in the following paragraph:

"Work under older engineers for at least 10 years, testing your judgment by theirs and by the results of their work. If this is done

systematically, trying to foresee necessary operations before they arise, and to make a decision in your own mind on all points before you learn that of your employer, you will gain rapidly in scope and reliability of judgment and obtain the very best preparatory training for the time when you will have to act quickly on your own decisions, without testing their correctness by appeal to others. It seems to me a real misfortune for a young man to begin early to work for himself, to open an office. He should not do this until he has matured his judgment and learned the best practice of the day as a basis on which to use it; and he can in no other way do both so thoroughly and so quickly as by working under the very men whose works determine what is the best practice. There is another excellent reason why a young man should work for a long time under older engineers. He can in this way best avoid self-conceit and keep a true and modest estimate of his own abilities, with a knowledge of his weak points. Nothing will accomplish this so well as working under able superiors and measuring himself by them instead of by his equals or his subordinates. If at the head of an office of his own he is too likely to measure himself only with his subordinates, over-value his judgment in consequence, and perhaps be awakened to its true worth by some great error, with results which may set him back for many years. Make present money gain a secondary consideration, and gain in experience the first; and when you can do so, choose your position accordingly. Your real engineering education will come more largely in the ten years after you leave college than in the four years there; and you should be satisfied with receiving it not only free, but with a fair living in addition."

Gas Engines: The Number in Use and Their Applications.

By Mr. Bryan Donkin, M. Inst. C. E., in *Journal of Gas Lighting*.

About the end of the year 1896, the writer sent out circulars to most of the gas companies in the United Kingdom, requesting the engineer or superintendent in charge to kindly furnish him with the number of gas engines working in the village, town, or city of his district. Replies were obtained from 438 companies; and to all these gentlemen he returns his thanks for the information supplied. He thinks a short summary may be interesting to engineers and others; and he adds a list of the number of gas engines in use in some of the largest towns. It will be seen that a very considerable number of these motors are now working in this country. For industrial purposes, this relatively new power has become a very important agent, especially within the last 10 or 15 years, during which time the workmen in many factories and shops have become accustomed to it. These convenient and useful motors do not require any steam boiler, and the smaller engines can be started with the greatest ease. Gas engines were first sold in England on a commercial scale about the year 1877, or only 22 years ago. Most gas companies allow a considerable discount off the price of the gas they supply, when a large quantity is used for power in the daytime. For this and other reasons, there will probably be a still greater demand in future for these motors.

In the subjoined list, one of the chief features is, the large number of very small engines—from 1-man to 1-horse power—used in a great variety of trades. Gas motors have at the same time increased in size, and many are now made up to 80 and 400 indicated horse power and more. In analyzing the various returns, the following figures may be of interest. In the London districts served by the three large Gas Companies—viz., The Gas Light and Coke, South Metropolitan, and the Commercial Companies—there were at the beginning of 1897 about 4,600 gas engines of all sizes from ½-man to 100-horse power. In the South Metropolitan Company's district alone, 150 ½-horse, 100 1-horse, and 120 2-horse engines were at work. In Paris, where gas is much dearer, there were at the same date about 2,300 engines, representing an aggregate of about 1,200-horse power. Birmingham comes next on the list with 1,480 engines; Glasgow, 1,235; Liverpool, 1,050; Manchester, about 1,000; Leicester, 571; Sheffield, 517; Bristol, 452; Bradford, 432; Belfast, 347; Nottingham, 300; Halifax, 250; Dublin, 262; and Sunderland, 230. In 50 other smaller towns, from 150 to 200 gas engines were working; 16 towns use from 100 to 150 engines each, and 37 towns from 50 to 99 engines. In certain other towns and villages not mentioned above, from 1 to 50 engines are running. As a rule, the industrial towns head the list for the number of gas engines in use; and these motors are largely employed for all varieties of trade purposes.

According to this return, the total number of gas engines working about January, 1897, in Great Britain, including London, was 27,700. It is interesting to compare this number with that of some of the towns in France and Belgium at the same period—viz.: Lyons, 775; Bordeaux, 296; Roubaix, 250; Lille, 207; Rouen, 95; Nice, 88; Fourcoin, 85; Toulouse, 35. In Central Europe, about the end of 1896, there were, according to *Engineering*, 15,650 gas engines working, equal to 52,700 nominal horse power. Up to the end of 1897, the number of gas engines sold in Germany and other countries was about 32,000.

A list of 65 trades served by these engines in England is added; probably the largest number being used for the production of the electric light. Printing and newspaper work in provincial towns come next. Sausage makers as well as butchers use them largely; and many are employed for blowing organs, for the manufacture of gloves and clothes of all sorts, and for laundry work. In gas works, small gas engines are often utilized to furnish power for a variety of purposes, such as breaking coke, pumping, hoisting, etc. In one town in the Midlands, the returns for all trade purposes show an increase of about 50 engines per annum, or an average of one per week. One firm alone employs a total of 400-horse power. The above figures relate only to the engines driven by gas supplied by gas companies.

There are, of course, many villages without either gas works or gas engines, and some are provided with gas works but have no engines. Enough, however, has been said to show that these new and handy motors are evidently appreciated by the industrial public, and every year sees additions to the number in use both in this and other countries, except perhaps in the United States, where there are comparatively few.

It is difficult to apportion the horse power of these engines in percentage to the number at work; but it will not be far wrong to estimate that in England from ½ to 5 nominal horse power represent about 50 per cent. of the total number of motors; from 5 to 10 do., 25 per cent.; from 10 to 20 do., 16 per cent.; from 20 to 50 do., 8 per cent.; from 50 to 100 do. and upwards, 1 per cent. In France, according to Professor Witz, there were in January, 1896, the following small number of gas engines for producing electric light: Eight stations with a total of 386-horse power driven by poor gas made on the spot; also 16 stations, with a total of 1,622-horse power using town gas.

The following figures show the number of gas engines made and sold in England and abroad by Messrs. Crossley:

	Engines.	Total I.H.P.	Size.
In 1877—1st year.....	133.....	798.....	1 to 8 N. H. P.
" 1878—2d year.....	448.....	2,670.....	Max. 12 to 18 N. H. P.
" 1879—3d year.....	590.....	3,540.....	
" 1880—4th year.....	782.....	4,692.....	
" 1898—21st year	2,971....	44,565.....	Max. 160 I. H. P.

Equal to about 10 per working day, or one per hour.

The total up to end of 1898 is 33,944 engines from 1 to 160 indicated horse power; giving a total of 436,400 indicated horse power, or for 21 years an average of 1,617 gas engines per annum.

The following are some of the gas-power plants working with Dowson gas: Blackpool, 1 of 950 I. H. P.; 24 others, in different towns, ranging from 870 to 200 I. H. P.; 34 from 190 to 100 I. H. P.; 26 from 90 to 50 I. H. P.; and 38 from 45 to 10 I. H. P., besides a large number of gas plants supplied to all parts of the world.

The number of Otto gas engines sold from 1877 to 1897, according to Mr. Dowson, is: In Great Britain and Ireland, 31,000 by Messrs. Crossley; in Germany, 17,000 by the Gas Motoren Fabrik, Deutz; in other countries, 15,000—total, 63,000 Otto engines in 20 years.

List of Purposes for which Gas Engines are Used.

Agricultural implement makers.
Air propelling.
Army clothing.
Artificial flower manufacturers.
Bakers.
Biscuit works.
Blowing fans.
Boot and shoemakers.
Bottle cleaning.
Bread kneading.
Brewers.
Builders.
Cabinet makers.
Cartridge makers.
Centrifugal fans.
Chaff cutting.
Clock makers.
Coach builders.
Coke breaking.
Contractors.
Corn crushing.
Corn merchants.
Cycle works.
Dairy work.
Electric lamp making.
Electric light.
Engineers.
Gas works (various uses).
Glove makers.
Grocers.
Hairdressers.
Hay chopping.
Hay stores.
Hoisting goods.
Horse clothing.
Joinery works.
Knitting stockings.
Lamp cleaning.
Laundry work.
Leather works.
Malt works.
Meat cutting.
Mineral water works.
Newspaper offices.
Paint manufacturers.
Pork butchers.
Printing.
Rope spinning.
Sail makers.
Sausage makers.
Saw mills.
Seedsmen.
Sewage pumping.
Shirt makers.
Silk weavers.
Smiths' fans.
Tanners.
Tobacco merchants.
Ventilating rooms and workshops.
Water pumping.
Wood chopping.
Wool works.
Workshops of all kinds.
Workshops (private).
Yacht builders.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. Frank W. Balty has been elected a Director in place of Mr. T. E. Perkins, on the Board of the Mystic (Conn.) Electric and Gas Light Company.

At the annual meeting of the shareholders in the Pittsburg (Pa.) Gas and Water Company the officers elected were: Directors, Calvin Fegely, George B. Lessig, William Auchenbach, M. S. Longaker, P. L. Egolf, Joshua B. Lessig and John W. Storb; President, George B. Lessig; Secretary and Treasurer, J. H. Maxwell.

The Altoona (Pa.) *Mirror*, of recent date, said that Messrs. John D. Blair and Robert W. Smith had applied to the courts for the appoint-

ment of a receiver to manage the affairs of the Hollidaysburg (Pa.) Gas Company.

MR. F. H. MACMORRIS, as Treasurer of the Equitable Illuminating Gas Light Company, of Philadelphia, announces that a semi-annual dividend of 3 per cent. on its preferred stock is payable on and after July 3d, to stockholders of record at the close of business the 23d inst.

MR. L. J. FITCH, Secretary and Treasurer of the Mason City (Iowa) Electric Company, informs us that the Company is about to construct a gas plant.

MR. BENJAMIN E. AITKEN, Superintendent of Works of the American Gas Company's property in Mt. Vernon, N. Y., died suddenly in that city the morning of the 9th inst. He was in his 29th year, and is survived by his wife and a daughter.

SENATOR MAHLON PITNEY, of Morristown, N. J., recently appeared before the Borough Council of Chatham, N. J., and applied, on behalf of the Morris County Gas Company, for the right to supply gas in Chatham. The Council appointed Messrs. Thomas W. Dawson, Edward L. Phillips and Frank L. Kelley, a committee to confer with the Company as to terms, rates to be charged for gas, etc. The committee was further instructed to report its findings to the next meeting of the Council, which is set for the 3d prox.

THE officers named to manage the affairs of the Kern Incandescent Gas Light Company are: President, H. Keene; Vice-President, Frank S. Hastings; Treasurer, Cassimir Tag.

A CORRESPONDENT in Cincinnati, O., forwards the following despatch from Marion, O., dated June 7th. The despatch was printed in the Cincinnati *Post*, dated June 7th: "Not a vote was cast by the City Council last night in favor of the proposed gas franchise, which had been asked for by Agent Ranger for P. F. Barnsdale, a Marietta capitalist. This was because of the startling statement made by Councilman Worlenweber. He said that an agent of the Gas Company had offered him the position of General Manager of the Company at $2,500 a year for 10 years, and that his duties should not occupy him more than an hour of his time each day. The Council likely will never grant the franchise."

THE proprietors of the Chico (Cal.) Gas Company have authorized the establishing of a selling rate of $2.50 per 1,000 cubic feet. The former rate was $4.

AT the annual meeting of the Georgetown (D. C.) Gas Light Company the following officers were elected: Directors, Henry C. Winship, M. J. Adler, John Marbury, S. T. Brown, Robert D. Weaver, William B. Orme, George Nicolson and William A. Leetch; President, H. C. Winship; Vice-President, M. J. Adler; Secretary and Treasurer, Frank P. Leetch; Superintendent, Robt. L. Middleton.

AT the postponed annual meeting of the shareholders in the Winona (Minn.) Gas Company the following organization was perfected: Directors, M. G. Norton, W. H. Laird, William Mitchell, Henry Stevens, H. W. Lamberton, H. S. Bolcom and R. T. Lamberton; President and Treasurer, H. W. Lamberton, Vice-President, Henry Stevens; Secretary and General Manager, C. A. Boalt; Executive Committee, W. H. Laird, Henry Stevens and H. W. Lamberton. This result seems to be a peculiarly happy adjustment of the differences between the proprietors as to who should be chosen to succeed the late Mr. H. C. Bolcom.

ON the 12th inst. the shareholders of the Los Angeles (Cal.) City Gas Company voted to increase the capital stock from $1,000,000 to $5,000,000, and to create a bonded indebtedness of $5,000,000.

EARLY this month Mr. Charles Van Norden, General Manager of the Central California Electric Company, issued the following notification to the shareholders in the Capital Gas Company, of Sacramento, Cal.: "We beg to inform you that the Sacramento Electric, Gas and Railway Company (the Folsom Power Company) has succeeded in securing a majority of the shares of the Capital Gas Company, and that only the necessary legal preliminaries defer a final and complete absorption of the latter by the former." Mr. George W. Jackson, Superintendent of the Capital Gas Company, when asked as to the meaning of the announcement, said: "The consolidation was bound to come, for there was not business enough for three companies in a lighting field like that of Sacramento."

A CORRESPONDENT in Vancouver, B. C., forwards the following under date of June 5th: "It has been definitely decided by the proprietors of the Vancouver Gas Company, that its manufacturing and distributing plants will be largely extended this season. Vancouver is growing, and the eastern shareholders of the Gas Company, recognizing such fact, have determined that it must keep up to the demands made upon it. The principal feature of the development in the spending of the money necessary (not less than $100,000) for the tasks proposed will be the extending of the main system. In fact every section where a demand for gas exists will be piped. Mount Pleasant will be piped and it is possible that Fairview will share in the betterment. The manufacturing plant on Keefer street will be practically reconstructed, on a scale that will enable it to supply Vancouver with all the gas needed by its residents for any 24 hours during the next decade. Mr. William McKenzie has been deputed by the shareholders to secure the engineering talent required to carry on and complete the work proposed."

THE Berlin Iron Bridge Company, of East Berlin, Conn., has been awarded a contract for the construction of a warehouse building (its dimensions are 40 feet wide, 120 feet long and 20 feet high) in Dutch Guiana.

MR. VINTON W. MASON, whose resignation from the Treasurership of the Malden and Melrose (Mass.) Gas Company takes effect July 1st, has been appointed Vice-President of the F. A. Dodge Company, of Malden.

AT the annual meeting of the shareholders in the Pawtucket (R. I.) Gas Company the following Directors were elected: Jas. G. Fales, Hezekiah Conant, Olney Arnold, Frederick W. Easton, Edwin A. Perrin, Stephen A. Jenks, Eben Littlefield, Jonathan Chace, Darius Goff and Lyman M. Darling. The annual reports showed that the Company had enjoyed a prosperous year's trading. The Directors subsequently named the following executive management: President, L. M. Darling; Secretary, E. A. Perrin; Treasurer, Charles L. Knight; Manager and Superintendent, Wm. McGregor.

THE Common Council of Marine City, Mich., have granted a franchise for the operation of a gas works there to Messrs. J. T. Lynn, F. D. Jenks and A. D. Bennett. The franchise is to last for 30 years, and it is stipulated that the work of construction will be commenced forthwith. Marine City, which is a post village in St. Clair county, Cottrellville township, Michigan, is located on the St. Clair river, at the mouth of the Belle river, at a point about 20 miles south of Port Huron and 42 miles by water northeast of Detroit. It is quite a manufacturing center, and at one time (for that matter, perhaps now) was noted for its output of small steamboats. Population, 6,000.

ON June 12th the papers were filed at Albany for the incorporation of the New York and Queens Gas and Electric Company, to operate in the city of New York, within the county of Queens, the purpose of the concern being the manufacture and supply of gas and electricity. It is capitalized in $1,000,000, and the Directors are: Edward J. Patterson, Edward C. Wilson, John F. Eagle, Charles F. Matthewson and Henry L. Snyder.

A RESOLUTION is before the Connecticut Legislature which proposes to incorporate the Willimantic Gas and Electric Light Company, with Messrs. Eugene S. Boss, George E. Stiles, Charles L. Boss, A. I. Bill, Solomon Lucas, Luther Hill, E. A. Hill, Emerson Stone, George P. Ladd, Edward Evans and T. C. Bates as Directors. The Company is capitalized in $125,000, and it may issue bonds in a like sum. The corporation is intended to merge the properties of the Citizens Gas Light Company, of Willimantic, and of the Willimantic Electric Company.

MESSRS. BARTLETT, HAYWARD & CO., of Baltimore, Md., have been awarded a contract for the construction of a gasholder, to rest in a steel tank, by the proprietors of the Glens Falls (N. Y.) Electric and Gas Light Company. The holder is rated to retain 100,000 cubic feet. The Glens Falls folks also propose to more than double the existing piping system.

A CORRESPONDENT in Denver, Col., forwards the following, under date of June 8th: "The Denver Gas and Electric Company is an actual fact, the change from the old to the new conditions having been completed yesterday. The Directors chosen were: Emerson McMillin, J. B. Grant, Geo. W. Skinner, John C. Mitchell, H. K. Devereaux,

(*Continued on page* 936.)

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
EDITORS.

CHAS. E. SANDERSON,
MANAGER.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 32 Pine Street, New York.

The JOURNAL is the official organ of the
NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
AMERICAN GAS LIGHT ASSOCIATION.
WESTERN GAS ASSOCIATION.
OHIO GAS LIGHT ASSOCIATION.
PACIFIC COAST GAS ASSOCIATION.

TERMS:

SUBSCRIPTION—Three Dollars per annum, in advance. Single copies, 10 Cents.

Notification Respecting Advertising.—Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Co., 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, JUNE 19, 1899.

(*Continued from page* 935.)

A. S. Hughes, H. C. James, J. H. Poole, C. W. Waterman, Geo. T. Thompson and E. W. Rollins—later on two more Directors will be named. The Directors organized by electing the following executives: President, George T. Thompson; Vice-President and General Manager, J. H. Poole; Treasurer, George T. Thompson; Secretary, Frank W. Frueauff. The following changes in the selling schedule for gas were determined upon: On illuminating account, $1.50 per 1,000 gross, with 15 cents off for prompt payment; on fuel account, $1.15 per 1,000 gross, with 15 cents off for prompt payment. The former net rates were $1.55 and $1 respectively. Although the net rate on fuel account is actually the same as before, a concession is virtually made, since the gross was $1.25 per 1,000, less 25 cents. No change was made in the charges for electric lighting, which have always been rather on the low side in Denver."

WE regret to have to add to our correspondents' notes as above that the changes in Denver mean the retirement of General Manager A. H. Branch and Secretary F. M. Herbert, of the old Denver Consolidated Gas Company. Both of these gentlemen, during their service with the Company, earned the confidence of their employers and the goodwill of its patrons.

MR. SOLOMON WARD, the recently appointed official inspector of gas and gas meters for Memphis, Tenn., has completed the fitting up of the testing rooms, etc. His headquarters are in the building on the corner of Exchange and Front streets.

AT a meeting of the Directors of the Newport (R. I.) Gas Light Company, the Hon. Melville Bull was elected President, vice his father, the late Major Henry Bull. Mr. Henry Bull, Jr., was elected to the vacancy in the Board of Directors.

IN the reorganization of the Warren County Gas Light Company, of Phillipsburg, N. J., these Directors were selected: Clarence Walters, Siddon Flick, William H. Walters, R. J. Flick, William H. Taylor, Charles Culver, Theo. F. Lozier and L. H. Roberts. Important plant betterments are proposed.

The Market for Gas Securities.

The city gas share market showed some animation this week, and quotations were sufficiently varied to suit the most enthusiastic speculator. Consolidated moved up sharply from Friday last, the high point being practically 183. To-day (Friday) the nominal quotation at noon was 181, but the trading was within very narrow limits. The advice to purchase Consolidated is being so freely given that one may be excused for holding the belief that "things are not what they seem." The rate war goes merrily on, and consumers are thanking the magnates for their exceeding great charity, but in the interim the small gas share proprietors are not at all easy in mind. The latter, however, should remember that the magnates are not in this contest for sport, and our advice to the small ones is, failing ability to buy, not to sell.

A report of the sale at auction this week, of 39 shares of Mutual gas, at 250, directs the expression that the purchaser got a bargain. One result of that sale is the lowering of the nominal bid price to 250, but it is not of record that holders are accepting the proffer with avidity. A fairer estimate of its value would be just 100 points higher. Amsterdam common is 34 bid, and the preferred is 58 to 59½. Standard common does not seem to have been much affected by the cut in the dividend rate. It would be a clever prophet who could predict when the New York rumpus will end, but some sort of a settlement must be reached before the end of the summer.

Brooklyn Union is firmly held, at a good advance over last week's figures, and Peoples, of Chicago, is again at something like its true value, being quoted at noon to-day at 120¾ to 121. Bay State is very weak. It sold down to 2, and now is bid at 2½, offered at 2¾. Cincinnati gas is 187 bid, and the likelihood is that it will go back to the 200 mark, even though the Company has decided to lower its selling rates to 75 cents per 1,000 for illuminating and to 50 cents per 1,000 for fuel use. Lacledes are steady, and the general situation is favorable to the investor. The Eastern gas shares, notably those of New Haven and Hartford, show great strength, which is readily explainable on the ground that the development in their trading is really remarkable. United Gas Improvement Company shares are also gaining ground over recent quotations, and our belief is that at anything under 175 they are decidedly a purchase.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

JUNE 19.

☞ All communications will receive particular attention

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$39,078,000	100	181	181½
Central Union, Bonds, 5's.	3,000,000	1,000	107½	108½
Equitable Bonds, 6's	1,000,000	1,000	105	.
" 1st Con. 5's	2,300,000	1,000	115	118
Metropolitan Bonds	658,000	.	108	112
Mutual	3,500,000	100	250	..
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	
New Amsterdam Gas Co.	13,000,000	100	34	34¾
Preferred	10,000,000	100	58	59½
Bonds, 5's	11,000,000	1,000	100½	101
Northern Union, Bonds, 5's.	1,250,000	1,000	95	97
New York and East River				
Bonds 1st 5's	3,500,000	1,000	109	111
" 1st Con. 5's	1,500,000		112	114
Richmond Co., S. I.	348,650	50	70	..
" Bonds	100,000	1,000	..	
Standard	5,000,000	100	110	120
Preferred	5,000,000	100	126	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	112	114
Yonkers	299,65	500	130	.
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	140	141
" " Bonds (5's)	15 000,000	1,000	118	119
Bay State	50,000,000	50	2¼	2¾
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	40	..
" 1st Mtg. 5's	450,000	1,000	95	98
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	92	..
2d " " "	3,000,000	1,000	68	71
Buffalo City Gas Co.	5,500,000	100	12	14
" " Bonds, 5's	5,250,000	1,000	89	91
Central, San Francisco	2,000,000	..	105	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Columbus	1,144,700	100	70	75
1st Mortgage	1,207,000	1,000	106	108
Consumers, Jersey City	2,000,000	100	95	.
" Bonds	600,000	1,000	107½	110
Cincinnati G. & C. Co.	8,500,000	100	186	187
Consumers, Toronto	1,700,000	50	230	235
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	11,000,000	100	62	62½
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	23	25
" Con. Mtg. 5's	380,000	1,000	80	82
Consolidated G. & E. Co.'s, Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,560,000	50	65	65½
" Prior Lien 5's	4,546,000	1,000	94¼	94½
Detroit Gas Co., 5's	423,000	1,000	95½	96
" Inc. 5's	31,000	100	..	..
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	62	65
" Bonds	2,000,000	..	80	85
Grand Rapids Gas Lt. Co.	1,000,000	50	..	..
" 1st Mtg. 5's	1,125,000	1,000	..	..
Hartford	750,000	25	..	220
Indianapolis	2,000,000	..	122	128
" Bonds, 6's	2 650,000	..	105	106
Jackson Gas Co	250,000	50	..	..
" 1st Mtg. 5's	250,000	1,000	..	..
Jersey City	750,000	20	225	275
Lafayette Gas Co., Ind.	1,000,000	100	68	70
Bonds	1,000,000	1,000	81	86
Louisville	2,570,000	50	106	108
Laclede, St. Louis	7,500,000	100	53½	54
Preferred	2,500,000	100	99	102
Bonds	10,000,000	1,000	107	108
Madison Gas & Elec. Co.	400,000	100	68	70
" 1st Mtg. 6's	350,000	1,000	102	..
Montreal, Canada	2,000,000	100	200	..
Newark, N. J., Gas Co.	1,000,000	..	200	220
Bonds, 6's	4,000,000	..	128	130x
New Haven	1,000,000	25	280	300
Nashville Gas Lt. Co.	1,000,000	50	110	..

Oakland, Cal.	2,000,000	..	53¼	55
" Bonds.	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago.	25,000,000	100	120¾	121¼
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage.	20,100,00	1,000	111⅛	112
2d "	2,500,000	1,000	104	105
Peoples, Jersey City.	500,000	50	215	..
Rochester Gas & Elec. Co..	2,150,000	50	88	..
Preferred.	2,150,000	50	118	..
Consolidated 5's.	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	74	75
St. Paul Gas Light Co.	1,500,000	100	50	52
1st Mortgage 6's.	650,000	1,000	82	85
Extension, 6's.	600,000	1,000	..	..
General Mortgage, 5's	2,428,000	1,000	80	82
St. Joseph Gas Co.	1,000,000	100	..	..
" 1st Mtg. 5's.	750,000	1,000	.	..
Syracuse, N. Y.	1,750,000	100	16	19
Bonds.	1,612 000	1,000	85	89
Washington, D. C	2,000,000	20	250	..
First mortgage 6's.	600,000	..	..	..
Western, Milwaukee	4,000,000	100	97	97¾
Bonds, 5's.	3,830,500	.	106	108
Wilmington, Del.	550,000		208	..

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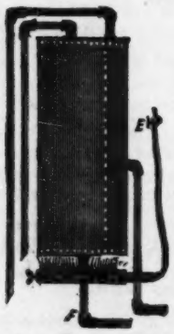

PERFECT COMBUSTION. NO SMOKE. NO ODOR.

FULLY GUARANTEED.

Will heat the Water in a Boiler in less than half the time required by a Range, and at less than half the expense. Nothing to get out of order, and will last a lifetime.

BUFFALO CITY GAS CO., BUFFALO, N.Y., April 1, 1899.

J. P. B. SADTLER & Co., 813 S. Howard St., Baltimore, Md.

Gentlemen—Replying to your favor of the 30th of March. The Heller Heaters that you have already furnished seem to be large enough, and we will not at present care to use any of the larger size that you mention. We have had no complaint in regard to the Heller Heater that we have used in Buffalo, and so far they are giving us good satisfaction.

Yours very truly, E. H. JENKINS, Engineer.

BALTIMORE, MD., March 24, 1899.

J. P. B. SADTLER & Co., 813 S. Howard St., Baltimore, Md.

Gentlemen—A test of the Heller Water Heater witnessed by me March 21, 1899, showed that with a consumption of 30 feet of gas per hour, the water in a 28-gallon galvanized boiler could be heated from 59° to 102°, or 43° in one hour. Temperature of room at time of test 64°.

Respecfully,

GEO. BEADENKOPP, Ass't Engineer, Con. Gas Co

Clamp Heater to Pipe about 4 Inches away from bottom of Boiler. Always use an independent connection, or regular Gas Stove connection, so as to get a good flow of Gas.

J. P. B. SADTLER & CO., 813 South Howard Street, Baltimore, Md.

W. H. PEARSON, Prest. W. H. PEARSON, Jr., Vice-President. J. T. WESTCOTT, M.E., Manager. L. L. MERRIFIELD, M.Inst.M.E., Chief Engineer.

THE ECONOMICAL GAS APPARATUS CONSTRUCTION CO., LD.

American Offices: 269 FRONT STREET, EAST, TORONTO, ONT.
London Offices: 19 ABINGDON STREET, WESTMINSTER, S.W.

Telegraphic Address: "CARBURETED LONDON AND TORONTO."

The above Company have erected since 1893, or are now erecting, their universal type of Carbureted Water Gas Plants at the following Gas Works:

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Blackburn, Eng.	1,250,000
Windsor Street Works, Birmingham, Eng.	2,000,000
Saltley Works, Birmingham, Eng.	2,000,000
Colchester, Eng.	300,000
Birkenhead, Eng.	2,250,000
Swindon (New Swindon Gas Co.), Eng.	120,000
Saltley Works, Birmingham, Eng. (2d Contract)	2,000,000
Windsor St. W'ks, Birming'm, Eng. (2d Contract)	2,000,000
Halifax, Eng.	1,000,000
Toronto,	250,000
Ottawa,	250,000
Toronto (Second Contract, Remodeled),	2,000,000
Lindsay (Remodeled),	125,000
Belleville,	250,000
Ottawa (Second Contract),	250,000
Brantford (Remodeled)	200,000
St. Catherine's (Remodeled),	250,000
Kingston, Pa.	125,000
Montreal,	500,000
Peterborough, Ont.	250,000
Wilkesbarre, Pa.	750,000
St. Catherine's (Second Contract),	250,000
Buffalo, N. Y.	2,000,000
Winnipeg, Man.	500,000
Colchester, Eng. (Second Contract),	300,000
York, Eng.	750,000
Rochester, Eng.	500,000
Kingston, Ont.	300,000
Crystal Palace District, Eng.	2,000,000
Duluth, Minn.	300,000
Caterham, Eng.	150,000
Enschede, Holland,	150,000
Leicester, Eng.	2,000,000

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821-823 Eagle Av., N. Y.

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Draughtsman and Constructing Engineer.
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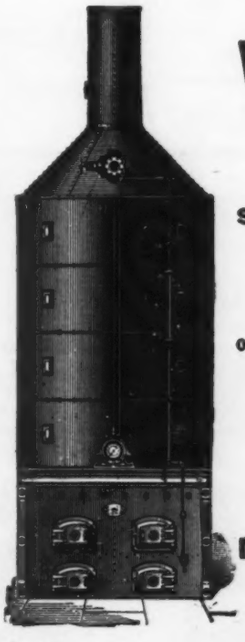
The Gas Engineer's
Laboratory Handbook.
By JOHN HORNBY, F.I.C.
Price, $2.50.
A. M. CALLENDER & CO., 32 Pine Street, N.Y. City



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THE HAZELTON OR PORCUPINE BOILER
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SINGLE BOILERS OR COMPACT BATTERIES.
GREAT SAVING OF FLOOR SPACE AND FUEL.
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GAS WATER HEATERS,
GAS KILNS,
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GAS OVENS,
GAS PLATE WARMERS,
GAS OYSTER STEWERS,
GAS CONTROLLERS,
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GAS GRIDDLES,
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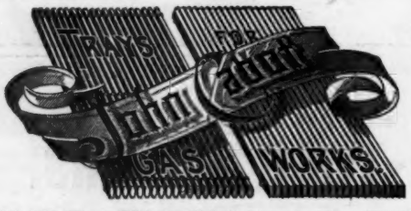
Reversible, Strongest, Most Durable, Most Easily Repaired.



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CONSULTING GAS ENGINEERS AND MANAGERS.
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PRESSURE GAUGE.

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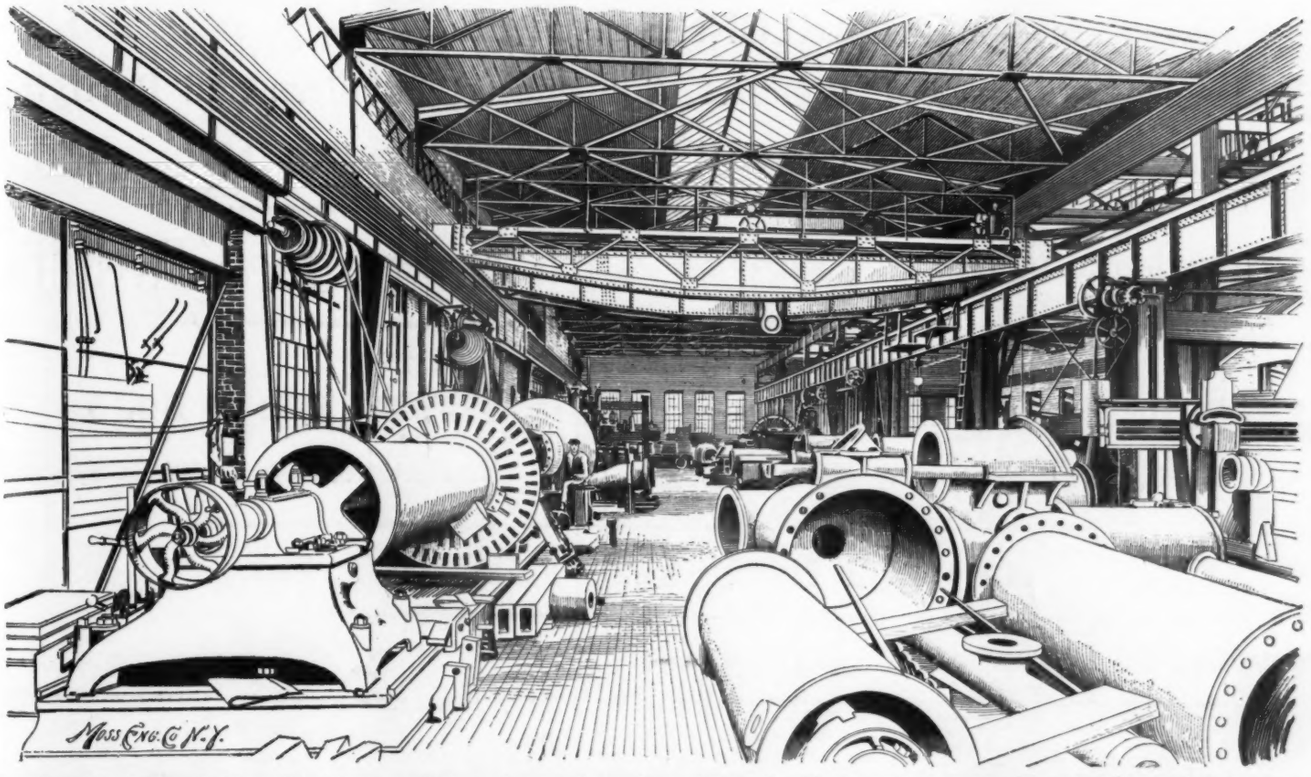

The above illustration is taken direct from a photograph and shows the interior of a Machine Shop designed and built by us for Henry R. Worthington's Hydraulic Works at Brooklyn, N. Y. The building is 44 feet in width by 198 feet in length, with a Traveling Crane of 10 tons capacity. Light for the interior of the building is secured entirely from the skylight in the roof.

BOSTON OFFICE, 200 Equitable Building.
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Nowhere else on this continent does such opportunity exist for profitable gas investment as on the Pacific Coast, since the perfection of the new LOWE Process for using the heavy crude California oils (of which there is an unlimited supply) without the use of any other fuels. Seven years' test proves the system to be perfect in every respect. Los Angeles alone, in addition to present street mains, has 150 miles of well built up streets without a gas main on them. To occupy this territory, and a large number of other towns now without gas, we have organized a parent company and a number of local companies covering some of the fastest growing cities in the United States.

Now is the time to invest, when the first capital will be able to double itself in a single year. This is also the most delightful residence section in the United States.

We suggest to those desiring gas investments, in large or moderate amounts—with or without active business connections—to come here and investigate; or, what is the next best thing, write us for particulars and prospectus.

The accompanying cut shows the oil wells in the suburbs of Los Angeles from which the Companies under the NEW LOWE GAS PROCESS obtain their supply of oil.

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Constructors of Coal Gas Apparatus.

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Exhausters, Blowers, etc.

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GEORGE G. RAMSDELL, General Manager. **Correspondence Solicited**

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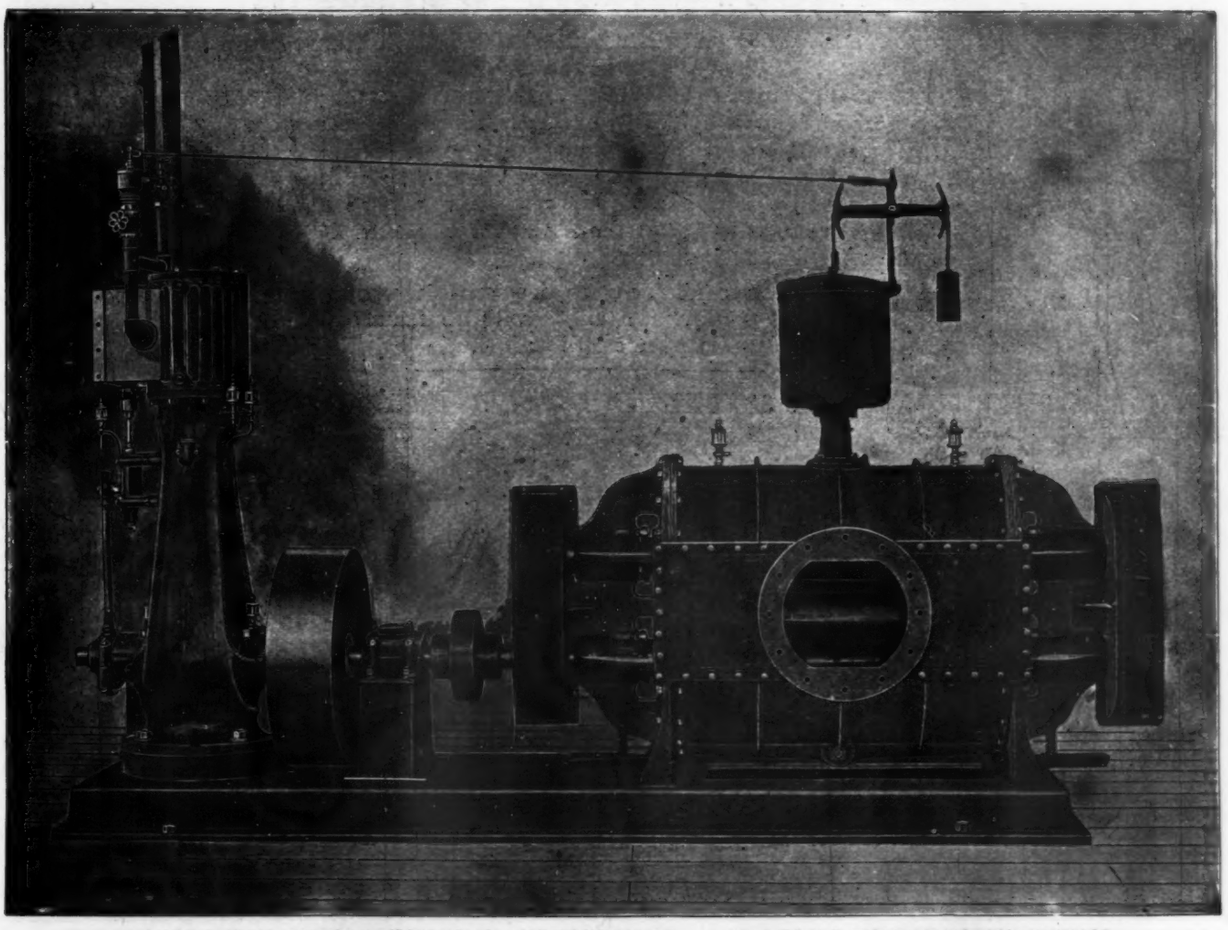
The Most Perfect Gas Governor on the Market.

MORE DIRECT IN ACTION. FEWER PARTS.
EASIER TO ADJUST THAN ANY OTHER GOVERNOR.



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Our PATENTED "STREET LIGHT APPLIANCES" have made WELSBACH STREET LIGHTING a complete success.

By the UNIFORM DISTRIBUTION of light on scientific principles a greater area can be lighted by our system and more economically than in any other way.

Where there are no gas mains already laid, we can furnish an equally good light by our **SELF-GENERATING NAPHTHA WELSBACH BURNER,** enabling Gas Companies to furnish a uniform light in all localities.

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This Edition of the "Handbook for Gas Engineers and Managers" is a great improvement on all previous editions Much of the text has been re-written, in order to keep the work abreast of the constant advances that are being made in the Gas Industry.

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With Instructions for Care and Working of the Same.

By G. LIECKFELD, C.E.

Translated with Permission of the author by GEO. M. RICHMOND, M.E.

Price, $1.00.

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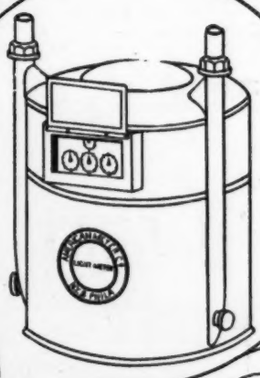

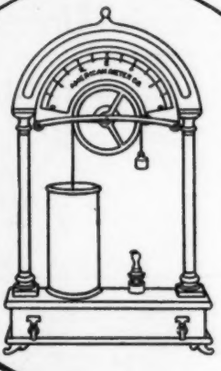

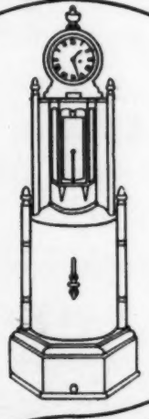

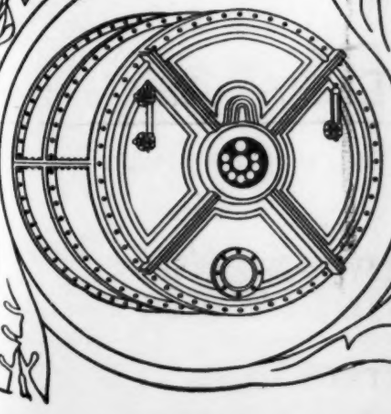

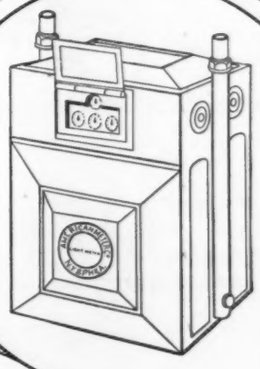

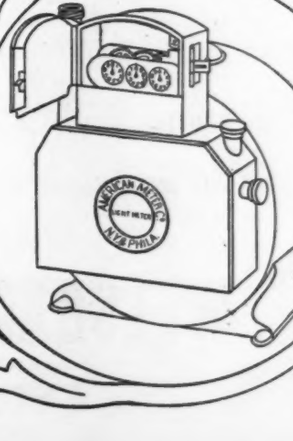

PUBLIC LIGHTING TABLE.

JULY, 1899.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Sat.	1	8.00 PM	1.20 AM	7.30	3.15
Sun.	2	8.00	2.00	7.30	3.15
Mon.	3	8.00	2.40	7.30	3.15
Tue.	4	8.00	3.40	7.30	3.15
Wed.	5	8.00	3.40	7.30	3.15
Thu.	6	8.00	3.40	7.30	3.15
Fri.	7	8.00 NM	3.40	7.30	3.15
Sat.	8	8.00	3.40	7.30	3.15
Sun.	9	8.00	3.40	7.30	3.15
Mon.	10	8.00	3.40	7.30	3.15
Tue.	11	8.00	3.40	7.30	3.15
Wed.	12	8 40	3.40	7.30	3.15
Thu.	13	9.10	3.40	7.30	3.15
Fri.	14	9.30	3.40	7.30	3.15
Sat.	15	10.00 FQ	3.40	7.30	3.15
Sun.	16	10.40	3.50	7.20	3.15
Mon.	17	11.10	3.50	7.20	3.15
Tue.	18	12.00 AM	3.50	7.20	3.15
Wed.	19	1.00	3.50	7.20	3.15
Thu.	20	2.10	3.50	7.20	3.15
Fri.	21	No L.	No L.	7.20	3.15
Sat.	22	No L. FM	No L.	7.20	3.15
Sun.	23	No L.	No L.	7.20	3.15
Mon.	24	7.50 PM	9.20 PM	7.20	3.15
Tue.	25	7.50	9.50	7.20	3.15
Wed.	26	7.50	10.20	7.20	3.15
Thu.	27	7.50	10.50	7.20	3.15
Fri.	28	7.50 LQ	11.30	7.20	3.15
Sat.	29	7.50	12 00 AM	7.20	3.15
Sun.	30	7.40	12.40	7.10	3.30
Mon.	31	7.40	1.30	7.10	3.30

TOTAL HOURS LIGHTING DURING 1899.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	215.40	January	423.20
February	184.40	February	355.25
March	187.40	March	355.35
April	166.50	April	298.50
May	158.00	May	264.50
June	140.50	June	234.25
July	150.30	July	243.45
August	168.30	August	280.25
September	179.50	September	321.15
October	213.20	October	374.30
November	217.00	November	401.40
December	238.10	December	433.45
Total, yr.	2221.00	Total, yr.	3987.45

Welsbach Patent Again Sustained.

Following the recent decision in the United States Circuit Court of Appeals, sustaining the Welsbach Company's Patent, Judge Lacombe, in the United States Circuit Court, has enjoined the following infringers of the Welsbach Patent:

DAYLIGHT INCANDESCENT GAS LAMP CO.
REX INCANDESCENT GAS LIGHT CO.
AMERICAN INCANDESCENT LIGHT CO.
NEW YORK CHEMICAL REFINING CO.
UNION INCANDESCENT LIGHT CO.
AMERICAN LIGHTING CO.
YOUNG & FLETCHER CO.
HECKLA MANTLE WORKS, Henry Anhalzer, Prop'r.
MERIDEN-ALBERTA MANTLE CO.

You are cautioned against infringement of the Welsbach Patent, as you will be held liable for an accounting.

All genuine Welsbach Lights bear the trademark "WELSBACH," and are for sale by all first-class dealers in Gas Appliances.

WELSBACH COMMERCIAL COMPANY,

Philadelphia.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia.

THE STANDARD JUNIOR,

THE STANDARD DOUBLE SUPERHEATER,

LOWE WATER GAS APPARATUS.

Under Contract, 1899:

	SETS.	DAILY CAPACITY.
Fostoria, O.	1	250,000 Cubic Feet.
Derby, Conn.	1	750,000 "
Lowell, Mass.	1	1,000,000 "
Doylestown, Pa.	1	50,000 "
Darby, Pa.	1	400,000 "
Adrian, Mich.	1	125,000 "
Concord, N. H.	1	400,000 "
Sioux City, Iowa	1	750,000 "
Standard Gas Light Co., New York	3	5,400,000 "
Peekskill, N. Y.	1	250,000 "
Westchester, N. Y.	1	250,000 "
Jersey City, N. J.	1	1,000,000 "
Stapleton, N. Y.	1	750,000 "
London, O.	1	125,000 "
Chicago, Ills.	2	3,600,000 "
Putnam, Conn.	1	125,000 "
Mansfield, O.	1	250,000 "
Plymouth, Pa.	1	125,000 "
Total	21	15,600,000 "
Previously built	294	187,100,000 "
Grand Total	315	202,700,000 "

Established 1858. Incorporated 1890.

CHAS. E. GREGORY Prest. DAVID R. DALY V. Prest. & Treas.
H. D. ABERNETHY, Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
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CLAY GAS RETORTS, FIRE CLAY TILES,
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Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

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Gas House and other Tile.

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Established 1854. Incorporated 1869.

LACLEDE
Fire Brick Manufg. Co.,

Manufacturers of { CAS RETORTS . .
FIRE BRICK . . .
RETORT SETTINGS

Water Gas Cupola Linings, Fire Clay, Etc.

Exclusive Agents for

The Mitchell Half-Depth Regenerative Furnace.

This is the *original* coal-consuming Furnace for Retort Benches. Burns either Coal or Coke. Full and Half-Depth Regenerative Furnaces for Benches of 6's, 7's, 8's or 9's erected complete.

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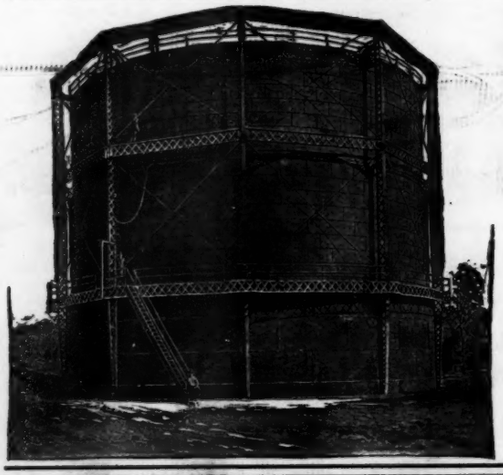

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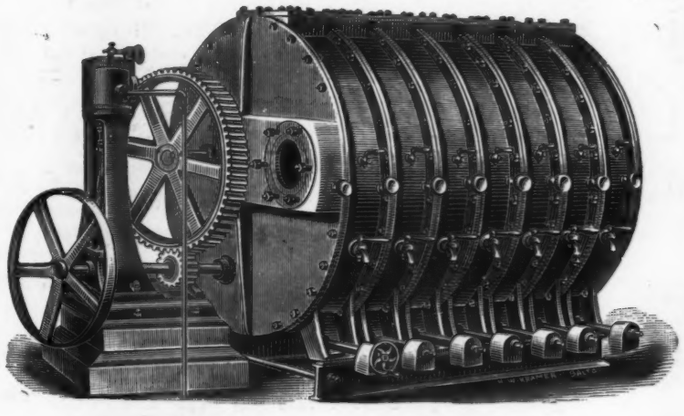

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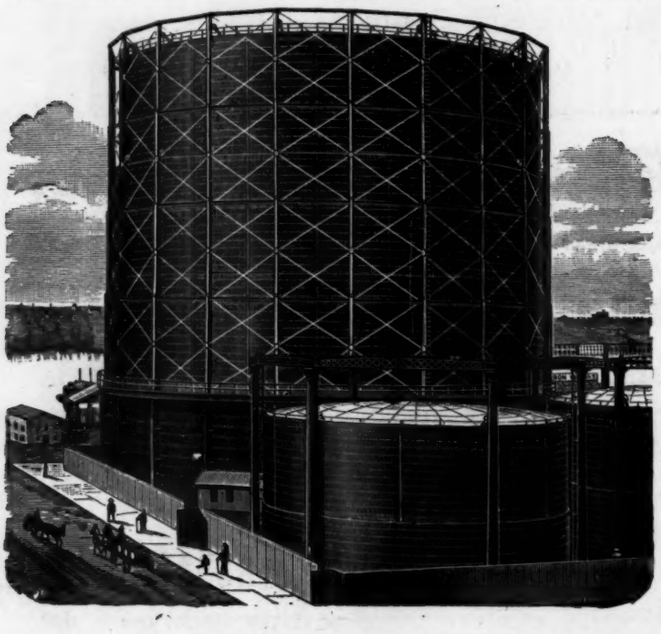

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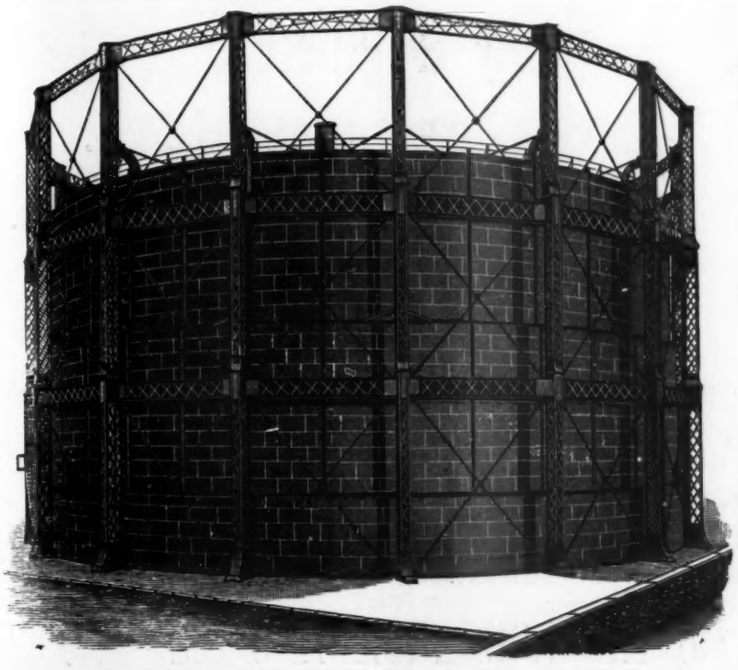

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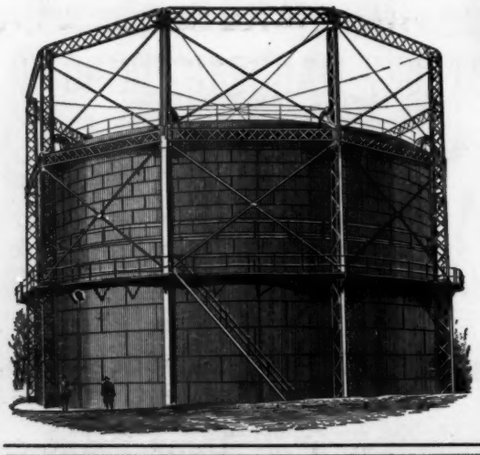

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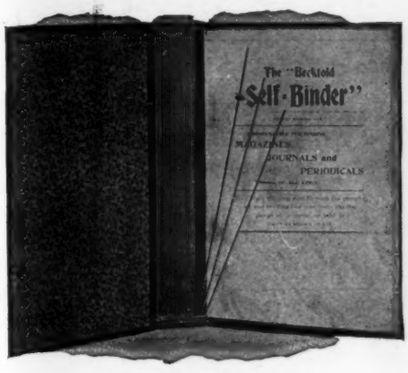

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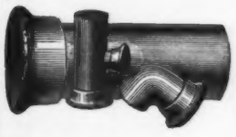

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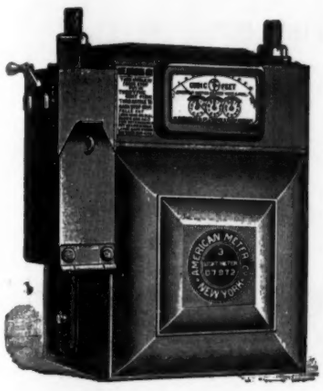

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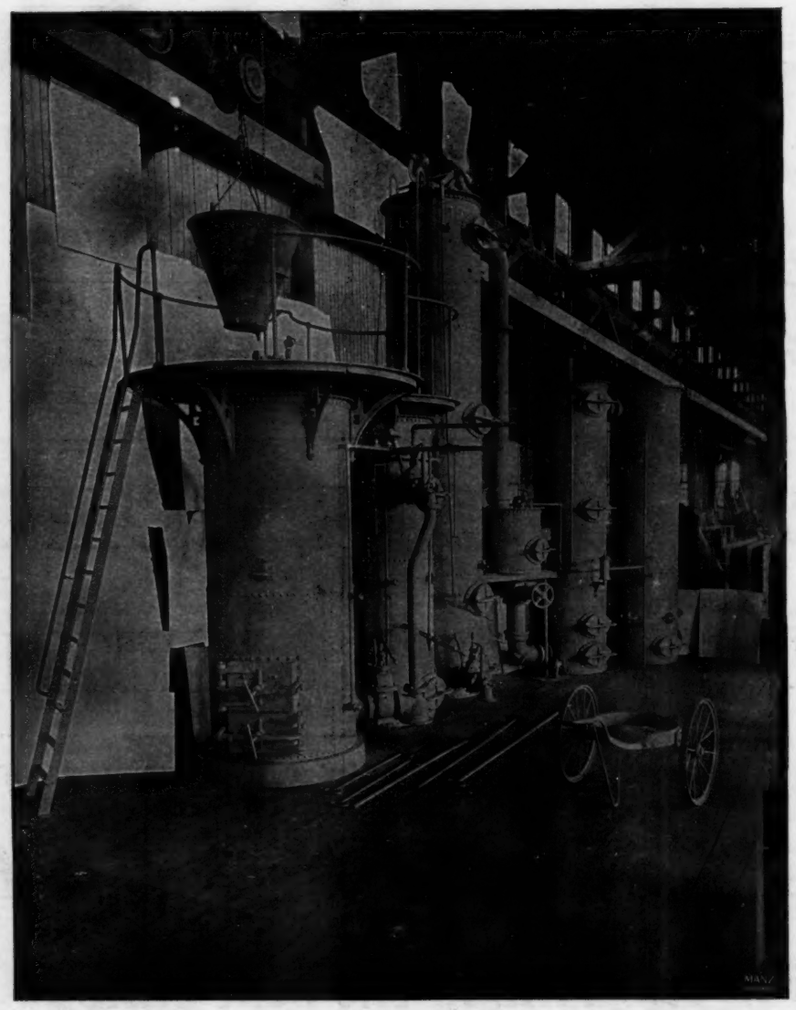

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